GRUNDODRILL 4X

STEERABLE BORING SYSTEM

User's Guide & Safety Manual

Includes Maintenance Guide & Parts Listings

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TT Technologies, Inc.

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General Information

1.

A. GENERAL DESCRIPTION

This operating manual deals with general safety instructions for operation of the machine as well as technical data and explanations as to the set-up and functioning of the machine.

B. FORWARD

This operating manual is considered to be an integral part of the GRUNDODRILL 4X system. It is an essential part of the user documentation. Adhering to the information, instructions and data in this manual is critical to successful equipment operation.

Technical data or information is subject to alteration without notice.

If you have questions or ideas concerning these products or this manual, please contact: TT Technologies, Inc. 1-800-533-2078 or 1-630-851-8200.

C. GENERAL USE OF THE OPERATING MANUAL

This operating manual details the safe, correct and proper usage of the Grundodrill 4x Drill, as well as the type of applications in which it is designated for. Adhering to the instructions, will reduce the risk of danger, repair costs and down time, while increasing the reliability of the machine.

Local regulations regarding prevention of accidents and safeguarding the environment should be adhered to in addition to those outlined in the operating manual.

This manual should be made available at every jobsite, at all times.

The operating manual should be read and the instructions applied by each person who works with the machine:

- During operation (including set-up, troubleshooting during operation, jobsite cleanup, maintenance, disposal of lubricants)
- During maintenance, inspection, repair
- Transportation

Besides the instructions of the operating manual and the regulations of safety prevention from the respective country or site of use, standard industry regulations for safety and operation practices should also be adhered to.

Safety

2.

A. GENERAL SAFETY INSTRUCTIONS

All safety devices and warning labels should not to be changed or removed from the machine.

Adhere to all instructions concerning safety and possible danger!

Keep all labels regarding safety and possible dangers on the machine in good, readable condition.

In case of safety relevant modifications to the machine or its operating mode, stop the machine immediately and notify the person in charge.

SAVE THESE INSTRUCTIONS

Only qualified and trained personnel should carry out operation of the machine.

Before starting the machine all safety requirements must be fulfilled.

Designated personnel should thoroughly study the operating manual, including all safety instructions and warnings, prior to the use of the machine.

New operators and operators in training should work under constant supervision of a qualified operator only!

The GRUNDODRILL is manufactured to the current technical safety-relevant regulations. Nevertheless, the use of the machine may represent a danger to the health and life of users or third parties. Always ensure that you pay particular attention to warnings, safety labels and instructions.

Read Operators Manual

Before starting the machine, fulfill all safety related requirements. All personnel should thoroughly read this operating manual.

Follow all safety instructions concerning safety and possible danger. Do not modify or remove the safety devices or warning labels of this machine. Keep all labels regarding safety and possible danger on the machine in good, readable condition. Special care is required before and during the safety check.

Every crew member should fully understand the safety measures required for the operation and should be capable of following these regulations individually.

Call Before You Dig

Check the existence and exact position of buried pipe and cables by contacting the respective utilities or owners of networks. The exact and definite existence and position of buried cables and pipes should be defined by trial pits or using cable and pipe detection equipment or other means.

Cable Strike

Should you accidentally hit an electrical cable, immediately leave the site, ensure no one enters and contact the electrical company to turn off the supply. In case of a cable strike, the danger resulting from that damaged electric cable can only be evaluated following detailed information by the respective electrical company. Never rely on your own knowledge as to types of cables, safety measures and protective measures that may not be correct for the type of cable encountered. Always consider cables to be “live” and a potential danger to life. Do not re-enter the site until authorized by the electrical company.

No Loose Clothes

Do not wear loose clothes or long hair. Danger of body injury by loose clothes or hair being caught in the moving parts of the machine.

Safety Equipment

The operating crew should always wear the appropriate safety equipment, i.e., safety shoes/boots, hard hat, safety glasses, gloves, ear protection etc.

Operation by Qualified Personnel Only

Operation of the GRUNDODRILL should be carried out by suitably trained, qualified, and certified personnel only. New operators or operators in training should be working under the constant supervision of a qualified person. Personnel operating the GRUNDODRILL should have sufficiently studied the operating manual.

SAVE THESE INSTRUCTIONS

B. OWNER AND OPERATOR RESPONSIBILITIES

The machine owner is obligated to restrict the operation of the machine to operators that:

- Have been made aware of basic regulations for work safety and accident prevention, and have been instructed in the correct operation of the machine.
- Have read and fully understood the operating manual, particularly the chapter on safety.
- Have been trained and instructed, and whose responsibilities as to operating, setting up, maintaining and repairing the machine have been clearly defined!

The operating personnel should carry out regular checks to verify safety conscious use of the machine.

The operating personnel should:

- Be qualified and trained in the respective field of application and should be familiar with the handling of the machine.
- Be informed at regular intervals about difficulties, dangers, and special procedures for operation of the machine.

C. TRAINING REQUIREMENTS

To attain maximum knowledge about the use of this system, the operators should be trained by TT Technologies' personnel.

Only trained and qualified personnel are permitted to work on the machine. Responsibilities of the staff as to the operation, set-up, maintenance and repair of the system are to be clearly defined.

New operators, or operators in training, should work under the constant supervision of qualified and experienced personnel only!

D. STAFF REQUIREMENTS

At least 2 workers are required for set-up, disassembly and operation of the GRUNDODRILL 4X boring system.

Before starting to bore all personnel charged with the use of the machine, are obligated to:

- Follow the basic work safety and accident prevention regulations.
- Thoroughly read the operating manual, particularly the safety instructions, and confirm that they have been fully understood.
- Use personal or work related protection clothing, or other means, to guarantee safety during the operation of the machine.

E. ACCIDENT PROCEDURE

- Cease immediately operations.
- Take the necessary protective steps according to the type of cable or pipe.
- Notify the owner of the cable or pipe.
- Estimate the type and extent of the damage.
- Warn pedestrians and house occupants, and keep them away from the danger.

F. PROTECTIVE MEASURES

In case of a telephone cable:

- Respect the cable protection instructions of the local telephone company.
- Notify the local telephone company.

CAUTION: Do not look closely at glass fiber cable! Risk of eye injury.

In case of electrical cable:

- Machine operator should not leave the machine
- Stay a safe distance from the machine
- Observe cable protection instructions
- Contact respective power company

DANGER: Electrical strike could result in severe personal injury or death.

In case of gas pipes:

- Do not operate with open flame
- Extinguish all flames, do not light new flames
- Shut down all engines
- Do not operate electric buttons or withdraw cable plugs
- Inform the respective gas company

WARNING: When smelling gas: risk of explosion!

In case of water pipes:

- Obtain information on the next available valve closing
- Call the local utility service department

In case of sewage pipes:

- Never enter into manholes or sewage mains alone
- Never enter into manholes or sewage mains without the proper safety gear
- Inform the respective owner of the pipe

Technical Specifications

3.

A. GRUNDODRILL 4X, SIZE RETRACTED & EXTENDED

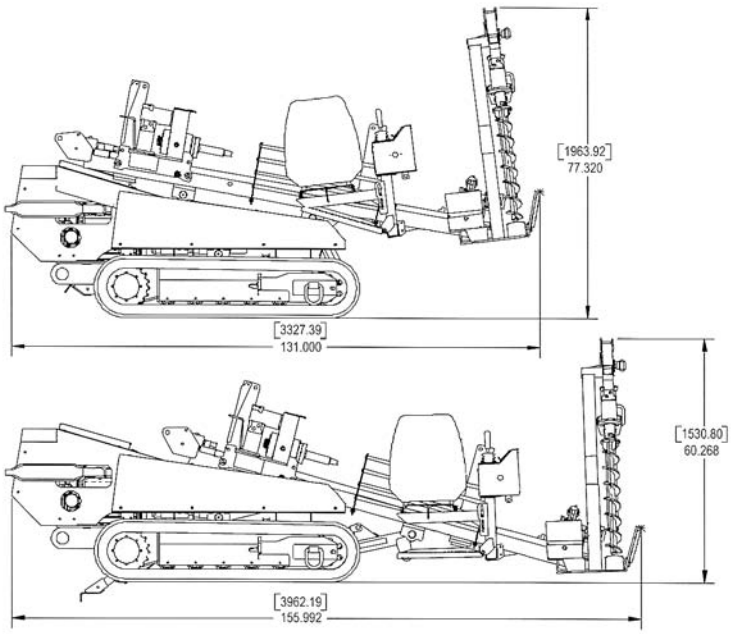


Figure 1. GRUNDODRILL 4X

B. TECHNICAL DATA

Grundodrill 4X Specifications	
Engine:	37.5 HP
Length x Width x Height:	130 in x 35.5 in x 70.5 in
Weight including drill stems:	4100 lbs
Pull back:	9,500
Thrust:	9,500
Max Torque:	1,100 ft-lbs
Spindle Speed:	230 rpm
Diameter Pilot Bore:	2.5 in
Diameter Drill Rod:	1.75 in
Length Drill Rod:	60 in
Diameter Back Ream:	8 in
Pipe OD:	6 in (dependent on conditions)
Bore Length:	dependent on conditions

Specifications subject to change at any time.

Grundomudd 225 Bentonite System	
Engine:	9.5 HP (gas) or 7.5 HP (diesel)
Length x Width x Height:	72 in x 46 in x 46 in
Weight:	650 lbs
Capacity:	225 gal (larger sizes available)
Max Operating Pressure:	800 psi
Max Operating Flow:	10 gpm

Figure 2. Technical Data

Overview

A. MAIN CHASSIS

4.

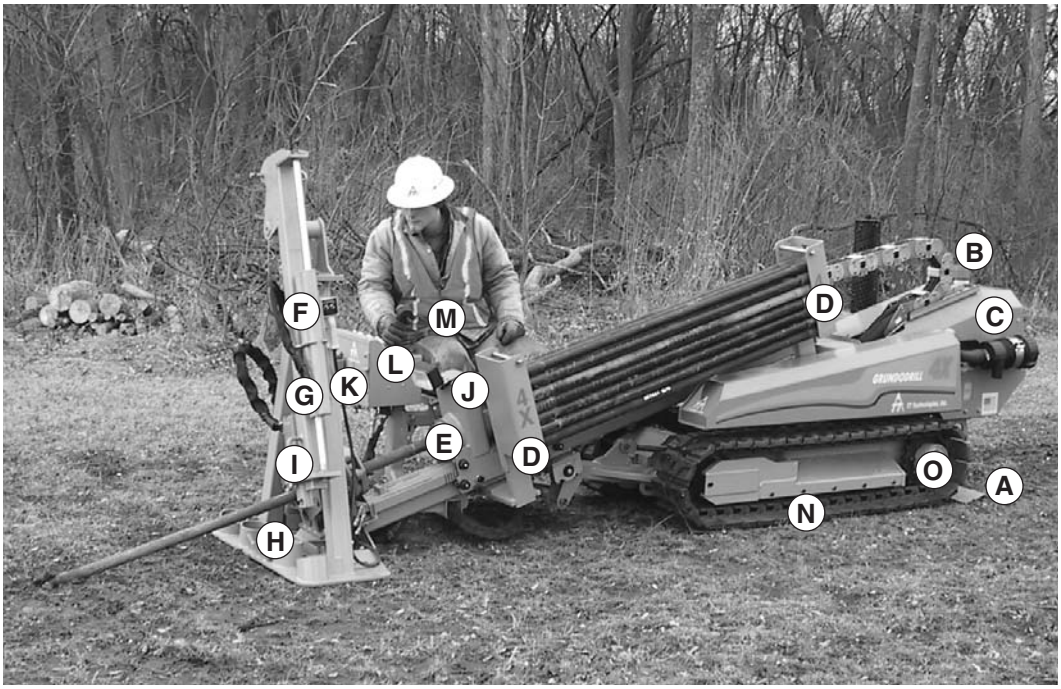


Figure 3. GRUNDODRILL 4X

A) Rear Stabilizer
B) Remote Track Drive
C) Diesel Engine
D) Drill Stem Carrier
E) Spindle Drive
F) Remote Stake Down
G) Stake Down Motor
H) Stem Whippier
I) Smart Vise
J) Thrust & Pullback Motor
K) Zap Alert
L) Control Panel
M) Operators Seat
N) Steel Track, w/Grounded Rubber
O) Track Drive Motor

B. CONTROL PANEL OVERVIEW

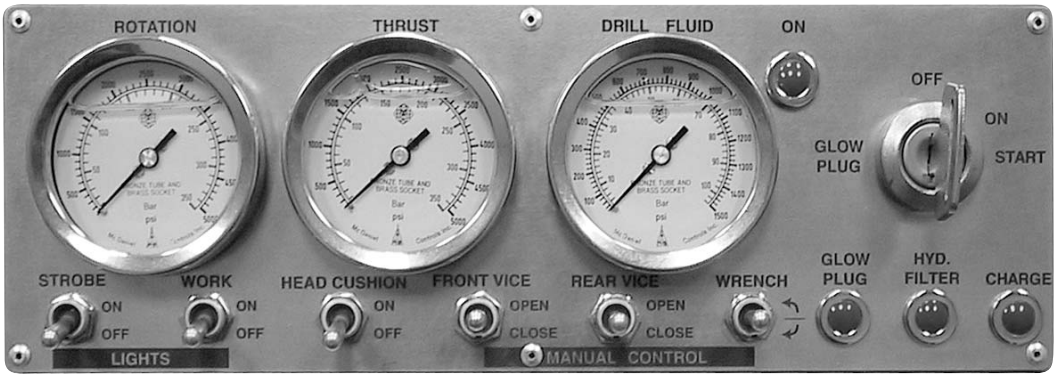


Figure 4. Upper Panel

Figure 5. Control Panel

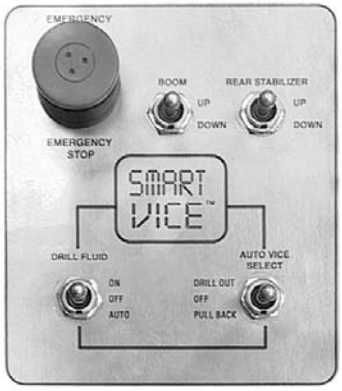


Figure 6. Lower Panel

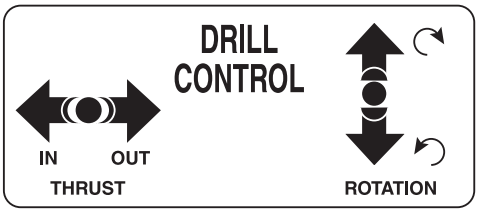


Figure 7. Joystick Control

Figure 8. Joystick

C. UPPER CONTROL PANEL

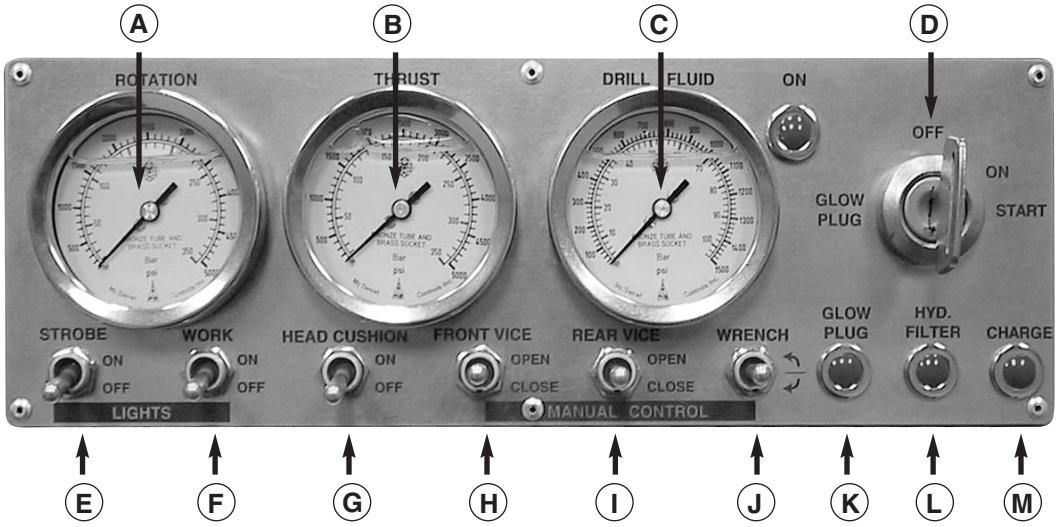
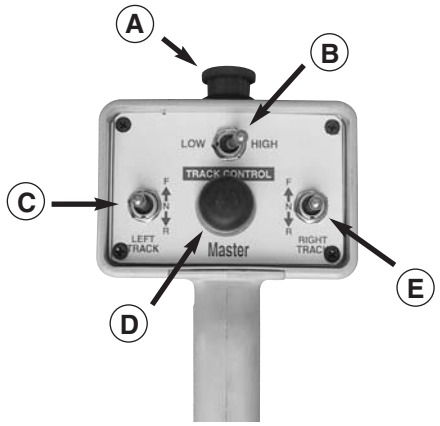


Figure 9. Upper Control Panel

A) Rotation Pressure (psi or bar)
B) Thrust Pressure (psi or bar)
C) Drill Fluid Pressure (psi or bar)
D) Ignition Switch (Preheat/Off/On/Start)
E) Strobe Light (On/Off)
F) Work Light (On/Off)
G) Head Cushion (On/Off)
H) Front Vice (Open/Closed)
I) Rear Vice (Open/Closed)
J) Wrench (Break Loose/Close)
K) Glow Plug Lamp (On-Preheating Plugs)
L) Hyd Filter Lamp (On-Electrical System)
M) Charge Lamp (On-Electrical System)

D. REMOTE DRIVE CONTROL



A) Emergency Stop (Push-Stop/Pull-Reset)
B) Speed Control (Low/High)
C) Left Track (Forward/Neutral/Reverse)
D) Master Button (Push-Engages Drives)
E) Right Track (Forward/Neutral/Reverse)

Figure 10. Remote Drive Control

Transportation

5.

⚠WARNING: • Never allow riders on the boring unit while moving or loading.
• Always load and unload trailers on level ground.
• Make sure boring rig is loaded correctly onto trailer, according to trailer size and type.
• Check that trailer is attached to vehicle before loading and unloading.

A. LOADING ONTO TRAILER

1. Make sure trailer is rated for the boring rigs size and weight.
2. Make sure trailer is correctly attached to towing vehicle.
3. Move boring rig to rear of trailer (Figure 11).
4. Align ramps with boring rig tracks (Figure 11).
5. With idle speed on low, and boom and stabilizer raised, slowly load boring rig onto trailer.
6. Position boring rig correctly on trailer (Figure 12).
7. Lower boom and stabilizer until they lay firmly on the trailer.
8. Shut engine off.
9. Attach boring rig to trailer with tie downs, & use the proper tie down locations (Figure 13).

Figure 11. Prepare Rig for Trailer

Figure 12. Position on Trailer

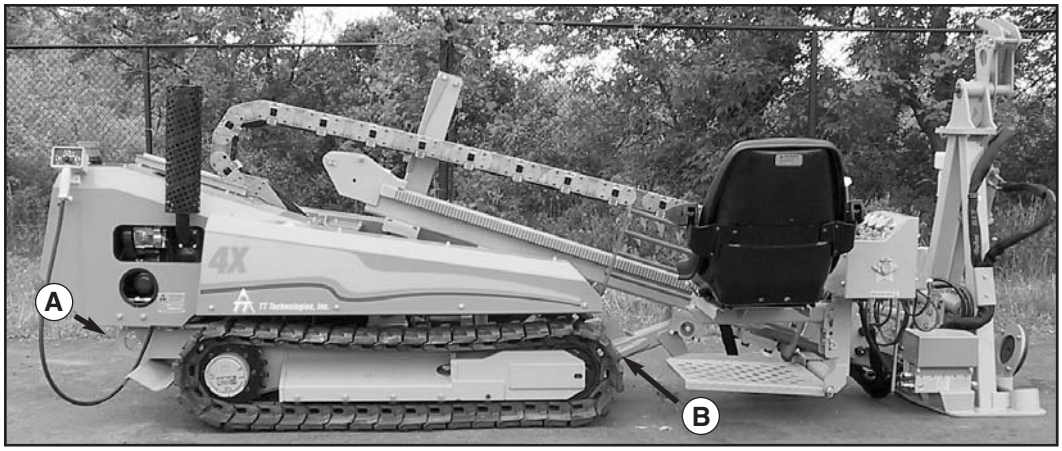


Figure 13. Tie Down Points

B. UNLOADING TRAILER

1. Make sure you are unloading on level ground.
2. Remove tie downs.
3. Lower trailer ramps.
4. Start engine.
5. Raise boom and stabilizer.
6. At a slow idle, slowly and cautiously back boring unit off trailer.

6. Jobsite Preparation

A. GENERAL

Many elements go into having a successful bore.

- Qualified Operators
- Jobsite Inspection
- Jobsite Planning
- Preoperational setup
- Proper setup and operation

B. INSPECTION OF JOBSITE

- Can the jobsite be easily reached?
- At which position is the starting point of the bore best suited?
- Where and how will the working pits be dug?
- Can the entire bore be done without any obstacles? (foundations, pipes, steel)
- Where will the bentonite system be located?
- Will the bentonite system hoses and electrical reach the boring unit?
- Will the bentonite system be refillable where and how it is positioned?
- Can the bore head be located in the length of the bore?
- What are the soil conditions?

C. PREPARATION OF THE JOBSITE

- Is there a complete location drawing of all buried cables and pipes?
- Have you called the local "One Call" for utilities?
- Have all buried cables and pipes been located, and exposed if needed, by the proper services?
- Have all required permits been obtained?

- What will the bore path be?
- What will be the entry position?
- Has the water source for the Bentonite system been identified?
- Is the pipe on site?
- What is the outside diameter of the pipe?
- Do you have the correct size backreamer to pull-in the O.D. of the product pipe?
- What are the individual lengths of product pipe?
- Does the contractor have the proper equipment to connect pipe? (fusion machine)
- How big should the pits be?
- Will there be any support personnel or lifting equipment?
- How and who will empty the pits of the drilling fluid to recycle the mud?
- Who assumes responsibility for accidents or various contractual shortcomings?
- Who assumes responsibility for environmental hazards?

D. SETTING UP THE JOBSITE

- Has the jobsite been prepared according to specifications?
- Have all maintenance procedures been properly carried out?
- Have all the safety precautions been taken?
- Has the Grundodrill 4x bore rig been properly positioned according to specifications?
- Are all the necessary boring tools and accessories available on site?
- Has the jobsite been marked off according to safety specifications?
- Secure the bore rig and operating space.

E. BORE PLANNING

Proper bore planning is critical to project success. Several considerations must be made in order to ensure a successful bore. These items include:

- Bend Radius
- Launch & Exits
- Minimum Set back
- Minimum Depth
- Pitch

1. Bend Radius

Creating the bore path depends on the bending of the drill stems. Creating bore paths that exceed the recommended bend radius of the drill stems will cause damage. Taking into consideration the minimum drill stem bend radius is essential to planning the bore path. Minimum bend radius for the drill stems used with the Grundodrill 4X is 96'.

2. Launch Area & Exit Pit

Launch area and exit pit should be selected to provide optimum drilling conditions. The launch area needs to be located where there is enough space to accommodate all drilling equipment and machinery and remain a safe distance from vehicle and pedestrian traffic. The launch area should also accommodate the drilling mud system.

3. Minimum Set-back (SB)

Because steering is dependent on the bending of the drill pipe, the drill needs to be positioned far enough back to accommodate the bending of the drill stem. The set-back distance is the length from entry to horizontal. To determine the necessary minimum set back refer to the chart and drawing found on the next page.

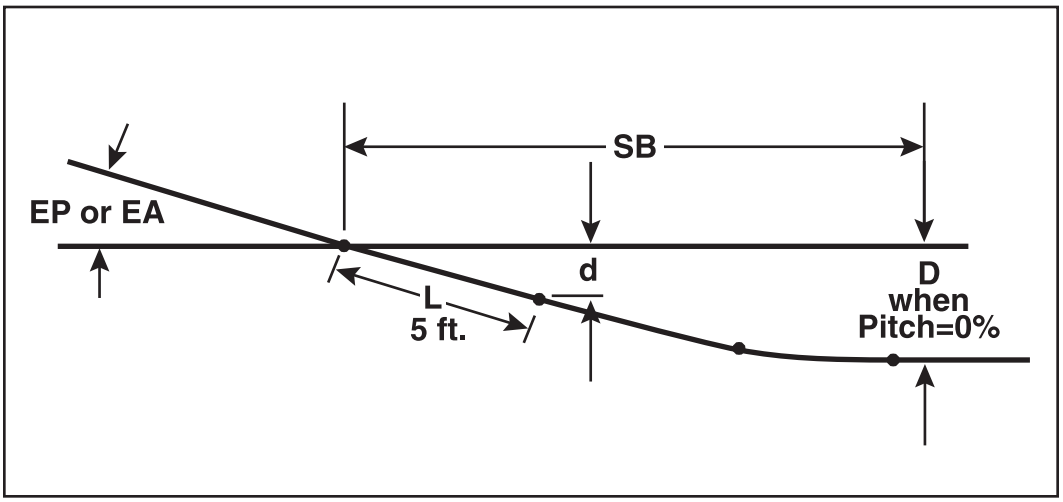
4. Minimum Depth (D)

Minimum depth is another consideration when positioning the Grundodrill 4X machine. Refer to the chart and drawing found on the next page to determine the minimum depth requirement for the specific bore path.

5. Pitch or Angle (EP or EA)

The entry pitch or entry angle at which the drill stem enters the ground directly affects the depth and length of the bore path. The entry pitch or entry angle is the Grundodrill 4X machine slope compared to level ground. Refer to the chart and drawing found on the next page to determine the entry pitch or entry angle requirement for the job.

GRUNDODRILL 4X - ENTRY PITCH, SET-BACK, AND DEPTH SPECIFICATIONS



Entry Pitch (EP)	Entry Angle (EA)	Set-Back (SB) (ft)	d (ft)	Minimum Depth (D) (ft)
26	14.6	29.057	1.26	4.36
28	15.6	30.632	1.345	4.88
30	16.7	32.376	1.437	5.486
32	17.7	33.95	1.52	6.065
34	18.8	35.671	1.611	6.733
36	19.8	37.22	1.694	7.369
38	20.8	38.764	1.776	8.032
40	21.8	40.294	1.857	8.722
42	22.8	41.811	1.938	9.439

Based on:
1) 96' minimum bend radius.
2) (d) Drill head, sonde housing, and 1/2 of first stem (totalling 5') in ground before steering.

7. Operation

A. SAFETY INSTRUCTIONS AS TO OPERATOR

- Operating personnel should thoroughly study the operating manual, specifically the chapter on safety instructions, prior to the using the machine. During the operation of the boring rig it is too late to study the operating manual! This is particularly true for operators that use the machine on an irregular basis for set up, maintenance or during operation.
- Daily check all hoses, pipe lines and securing bolts for correct position and function before starting the bore! Visual Check!
- Use only oils and lubricants recommended by the manufacturer!
- Only qualified and trained personnel should use the machine!
- Each member of the crew should fully understand the safety measures required for the operation and each one should be capable of the following the instructions individually.
- New operators or operators in training should be working under the constant supervision of a qualified and experienced persons only!
- Adhere to the legal minimum age for operators.
- Use only the machine in sound technical condition after having studied the operating manual, particularly the safety related aspects.
- Any safety disturbances should immediately be eliminated.
- Rotating and moving parts can present a dangerous situation: pulling or wrapping around.
- Open safety covers, doors, and other equipment only after shut down of the machine.
- The working area should be secured so the machine system contact with the public is prevented.
- Should a dangerous situation arise, toward people or the machine, immediately push the emergency ON-OFF button.
- Never operate the machine without properly installing the electric strike protection system.
- In case of an electrical strike the operator should **NEVER** leave the bore rig safety mats until there is a 100% confirmation that electrical source has been shut down.
- In case of cable strike, the respective electrical company can only evaluate the danger resulting from that damaged electric cable following detailed information.
- Never rely solely on your own knowledge as to the types of cable encountered.
- The entire bore crew should wear functional protective attire, including ear protection.

B. DRIVING TO OPERATION SITE

1. Safety Instructions

- Do not drive bore rig on steep slopes.
- Lift bore rig boom and rear stabilizer before moving rig.
- Always walk with machine while driving, **DO NOT RIDE ON BORE RIG!**
- Do not drive over any hydraulic hoses, bentonite hoses, or control cables.
- When driving bore rig off or on trailer refer to safety instructions in chapter 5.

2. Control Steps Prior to Starting

- Check the coolant level (Figure 14).
- Check the oil level (Figure 15).
- Check the diesel level (Figure 16).

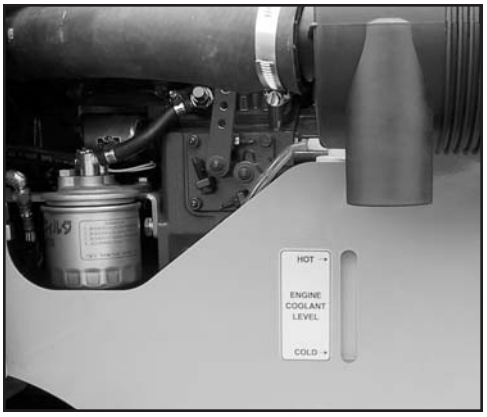


Figure 14. Check Coolant Level

Figure 15. Check Oil Level

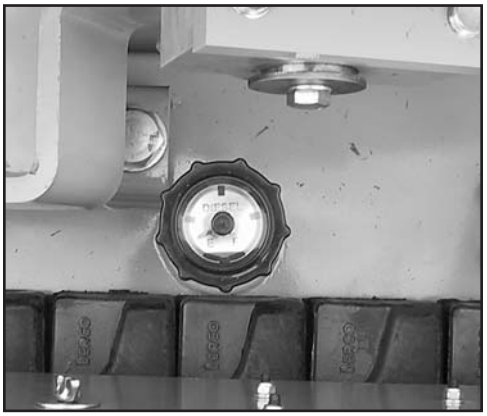
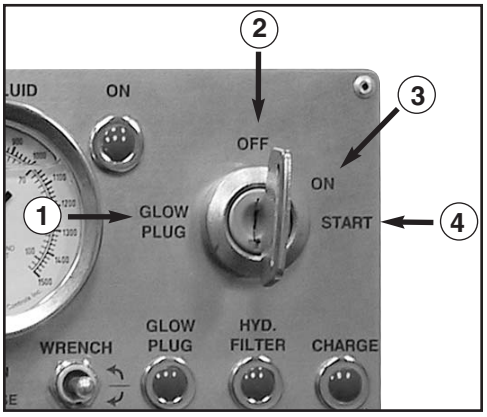


Figure 16. Check Diesel Level

3. Starting the Motor

1. Turn key to right to position 4 to start (Figure 17).
2. Release key as soon as engine fires (key will be in position 3).



Position 1	Preheat Glow Plugs (Only necessary for cold starting)
Position 2	Off
Position 3	On
Position 4	Start

Figure 17. Starting the Motor

4. Driving Bore Rig

Drive bore rig to operations site using the remote drive control. While driving bore rig adhere to all prior safety instructions.

For remote drive control switch positions refer to chapter 4 D.

Figure 18. Remote Drive Control

Figure 19. Remote Drive Control

To drive boring, move toggles to desired direction and then press Master Button and hold to put boring rig into motion (Figure 18).

To stop boring rig just release Master Button.

Toggle Steering Controls

Left Track	Right Track	Action
F	F	Forward
N	N	Neutral
F	N	Gradual Right Turn
F	R	Sharp Right Turn
N	F	Gradual Left Turn
R	F	Sharp Left Turn

5. Setting Up the Bore Rig for Operation

1. Drive the bore rig to the operating entry position (Figure 20).
2. Raise rear stabilizer to the height desired for entry angle. Using rear stabilizer toggle located on lower panel, (Figure 21).
3. Lower boom until boom plate is lying firmly on the ground. Using Boom toggle on lower panel, (Figure 21).

Figure 20. Operating Entry Position

Figure 21. Lower Panel

C. SET UP OF SAFETY ALERT PACKAGE

After the boring rig is in place the safety alert package for the boring rig must be set in place before boring or staking down of rig.

1. Take the grounding rod, connected to the zap-alert system and unwrap cord from the rig and extend the cord out (Figure 22).
2. Push the grounding rod into the ground-**approximately five to six feet away from the boring rig, and perpendicular to the boring path** (Figure 23)**.** (If an electrical strike has been made, the siren will continue to sound as long as current is passing into the machine and soil. If you attempt to reset the zap-alert, the siren will not stop until the current has stopped.

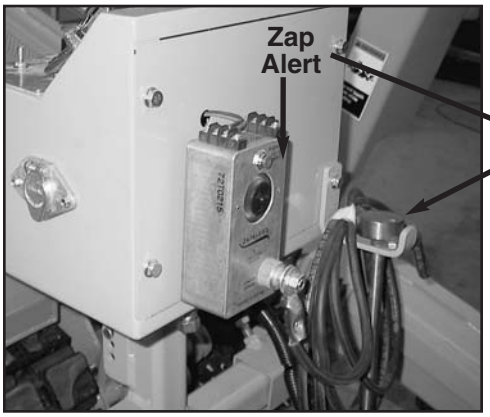


Figure 22. Zap Alert & Grounding Rod

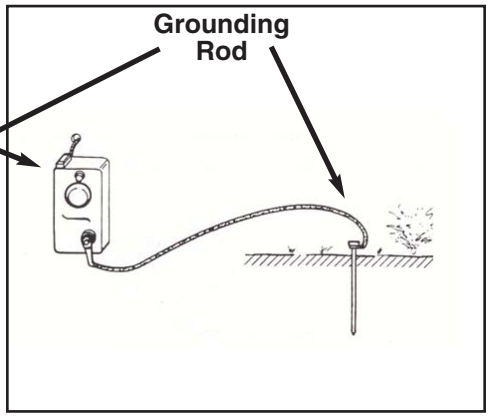


Figure 23. Grounding Rod

⚠WARNING: Do not stop the siren by resetting the zap-alert until you have confirmed that the electric power has been locked out. If the power has not been properly shut off, an automatic resetting circuit breaker could re-energize the power line, or contact between the boring rig and power line may recur.

Danger: The operator is not to leave the machine until all safety and electrical shut offs are confirmed and done according to safety standards.

3. Place the safety mat out parallel to the bore rig, and plug the cable into one of the sockets on the bore rig (a second safety mat can be laid out on the other side of the bore rig as an option) (Figure 24).
4. Connect the grounding stake to the other socket and insert the stake vertically, next to the bore rig, away from the safety mat (Figure 24).

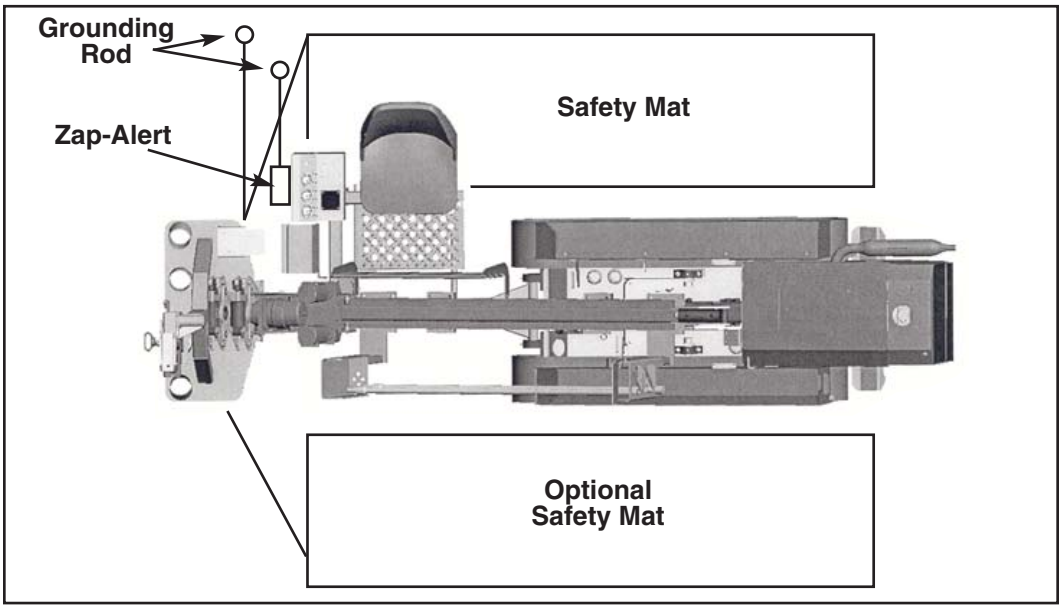


Figure 24. Overhead of Safety Alert Package

Safety Warnings

- Electrical strike could result in severe personal injury or death.
- Never start a bore without prior setting up of the complete safety kit!
- When placing stakes in the ground, the operator must be wearing electrical safety boots and gloves.
- It is important that the stake is placed in conductive soil.
- In extremely dry or asphalted soils prior watering of the ground is necessary.

D. AUGER STAKING DRILL IN PLACE

The bore rig comes with four auger stakes to secure rig to ground (Figure 25). The staking system is operated using a remote, which is located on the auger stake down (Figure 26 & Figure 27).

Figure 25. Auger Stake

Figure 26. Auger Remote

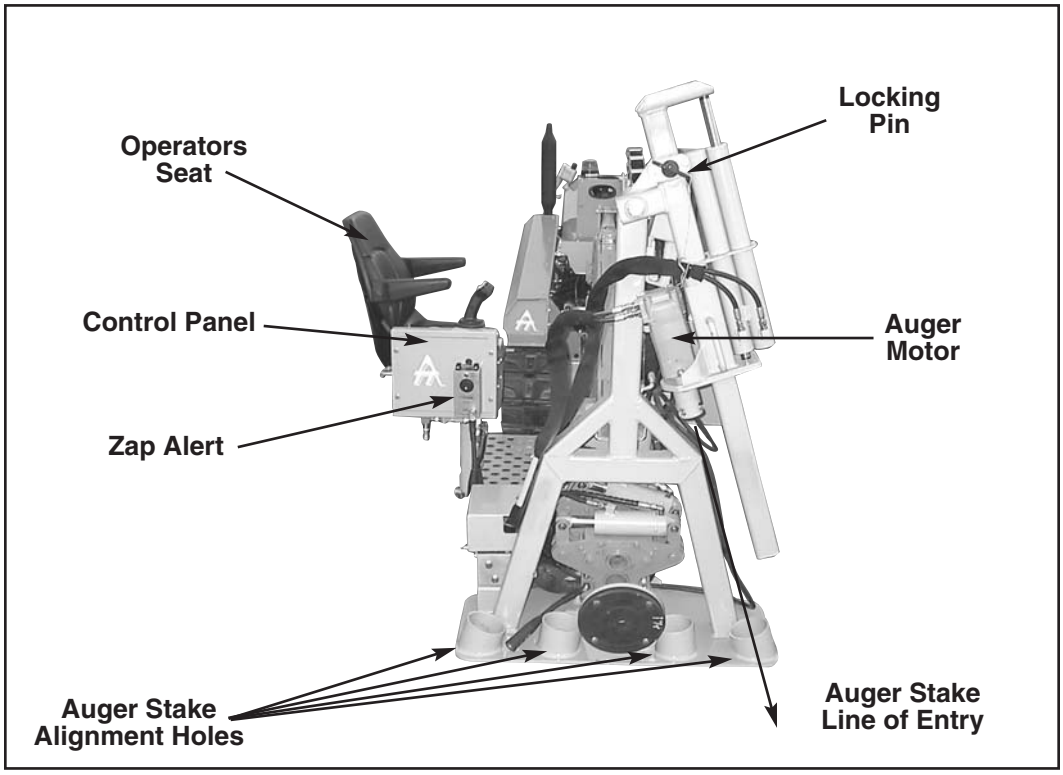


Figure 27. Stake Down System

The remote has two toggle switches (Figure 26).

1. Auger rotation (toggle up = auger in, toggle down = auger out)
2. Auger thrust up and down, rotates drive motor.

1. Setting Auger Stake

1. Bore rig must be running to operate auger stake down system.
2. Lock stake down guide into position using locking pin (Figure 27).
3. Place the auger stake into alignment hole (Figure 27).
4. Bring auger motor down onto auger stake until pins are fully engaged in auger motor chuck.
5. Push the auger rotation toggle forward to lock stake into auger chuck.
6. Run both toggles forward, this will put downward thrust and clockwise rotations on auger, screwing it into the ground.
7. Stop rotation and thrust when auger plate reaches top on alignment hole (Figure 27).
8. Repeat steps 2-7 until all four augers are in place.

E. PREPARING SONDE HOUSING

The drilling tool consists of the drill head, sonde housing and the transmitting sonde (Figure 28).

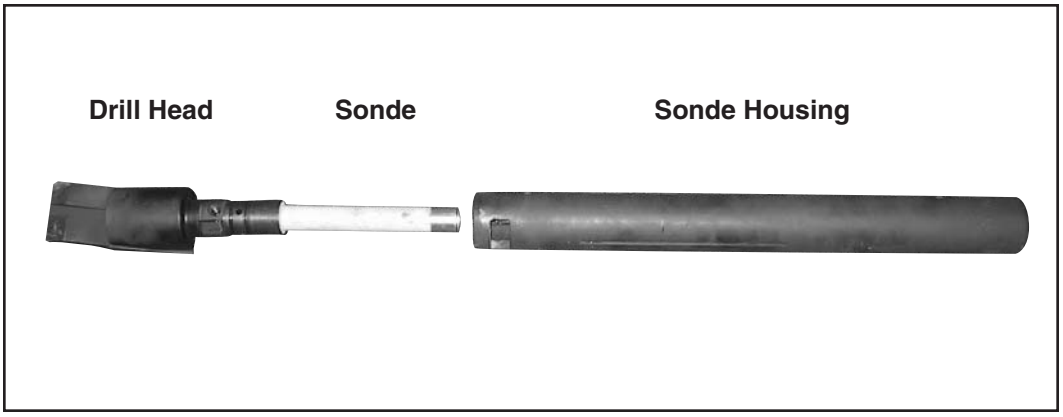


Figure 28. Drill Head, Sonde, Sonde Housing

1. Sonde Housing Assembly

1. Slide sonde into drill head matching sonde slot to pin in drill head (Figure 29).
   Note: This will lock sonde to 12 o'clock position on drill head.
2. Slide sonde and rear of drill head into sonde housing, with pin aligned (Figure 30).

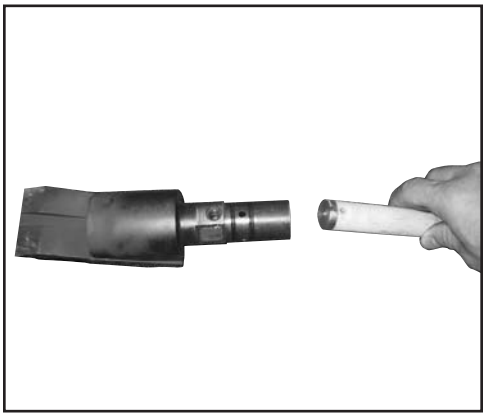


Figure 29. Slide Sonde into Drill Head

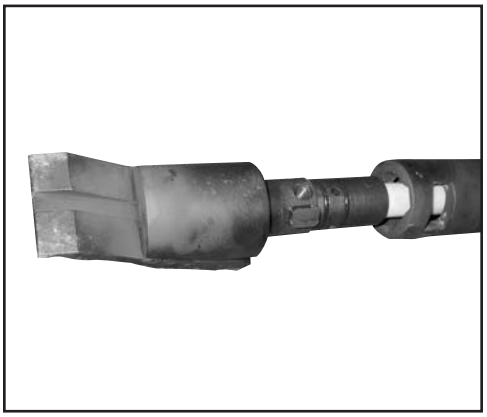


Figure 30. Slide Sonde & Rear of Drill Head into Sonde Housing

3. Rotate boring head 90 degrees in sonde housing until pins lock in place (Figure 31).
4. Insert cap screws to lock drill head onto sonde housing (Figure 32).

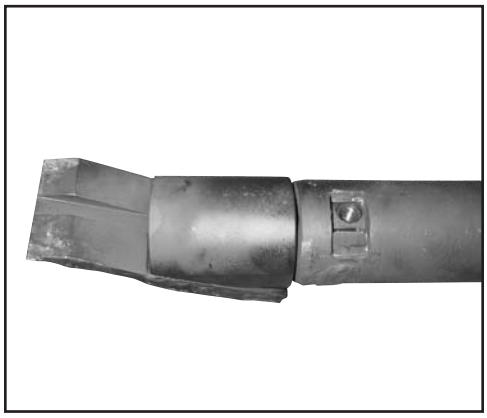


Figure 31. Rotate 90° Until Pin Locks in Place

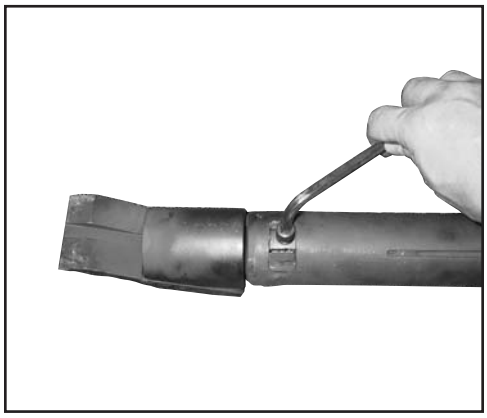


Figure 32. Insert Cap Screws to Lock Drill Head onto Sonde Housing

2. Calibrate Sonde

After preparing the sonde housing assembly, calibrate sonde in sonde housing according to the type of locating equipment being used.

With calibration complete, test sonde housing assembly with locating equipment for proper depth, roll, and pitch reading.

F. CONNECTING THE BENTONITE SYSTEM

The standard Bentonite system to be used with the 4X-boring rig is the TT Technologies 225 Bentonite system.

The connection of the Bentonite system consists of two hook-ups, the Bentonite hose and electrical connection (Figure 33).

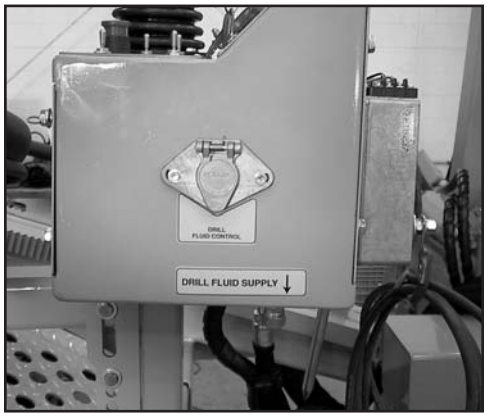


Figure 33. 4X GRUNDODRILL Bentonite & Electrical Connections

For operation of bentonite system, see bentonite systems manual.

G. BORE MODE

1. Safety Instructions

- The entire crew should read and fully understand all general safety instructions and operating safety instructions.
- Operators strict attention is required during the rotation mode!
- Danger of injury around all moving parts.

- No loose clothing or hair.
- **Never** have physical contact with stem while stem or spindle is in rotation mode.

2. Checks Prior to Boring

- Check the drill stem for fatigue or wear.
- Visual check of the o-ring on the drill stem.
- Check bore rig fluids for start-up.
- Has bentonite fluid been mixed and is the mixing system ready for operation?
- Check that all hoses and electrical cables have been connected correctly and are operational.
- Make sure that all communications (radio or hand signal) have been agreed upon between location operator and bore rig operator.
- Check that all safety precautions have been applied.
- Make sure that the strike alert system has been tested and is in good working condition.

3. Assembly of First Drill Stem with Sonde Housing

1. Take first stem in the left hand and place the male end of the stem in the vice (Figure 34).
2. With auto vice selected in the off position, close rear vice using toggle on upper panel (Figure 35).

Figure 34. Place First Stem in Vice

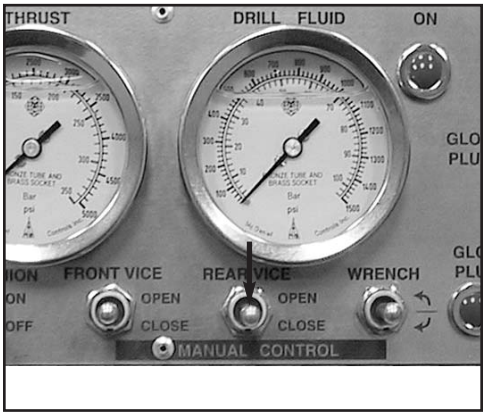


Figure 35. Close Rear Vice

3. Move the spindle head forward until the head leads into the female side of stem (Figure 36).
4. Release hand from stem.
5. Using the joystick rotate the bore head clockwise until head screws into first stem (Figure 37).

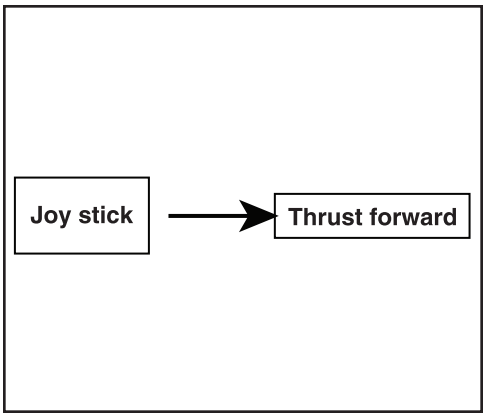


Figure 36. Move Spindle Head Forward

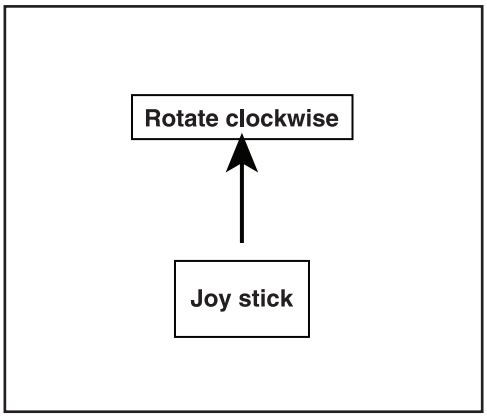


Figure 37. Rotate Bore Head Clockwise

6. Open rear vice (Figure 38).
7. Thrust stem forward until male end of stem protrudes the Smart Vice. Make sure both front and rear vices are open before thrusting stem forward (Figure 39).

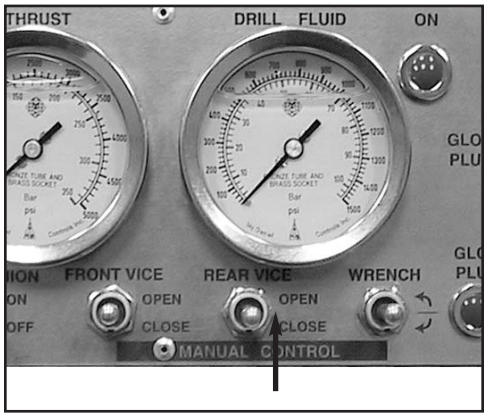


Figure 38. Open Rear Vice

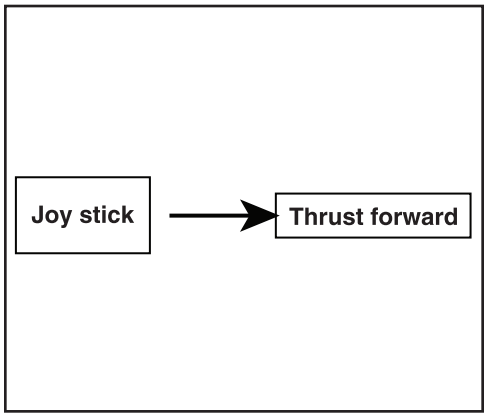


Figure 39. Thrust Stem Forward until it Protrudes Smart Vice

8. Manually turn on Bentonite fluid to flush away any foreign materials.
9. Screw sonde housing assembly onto male end of stem protruding (Figure 40) and tighten sonde housing assembly with a wrench.
10. Open both vices using toggles on upper panel (Figure 41).

Figure 40. Screw Sonde Housing Assembly onto Male End

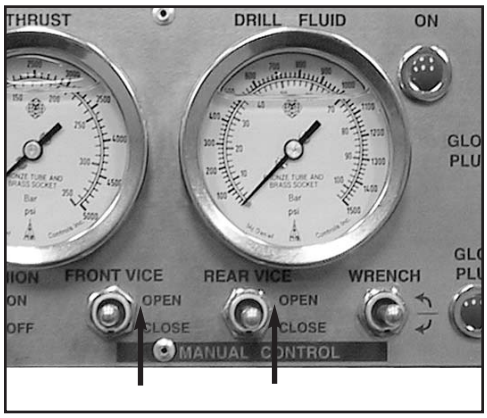


Figure 41. Open Both Vices Using Toggles on Upper Panel

11. Rotate drill head to the 6 o'clock position.
12. With Bentonite system running, turn drill fluid on to check whether drill fluid exits bore head.
13. Using joystick thrust spindle forward until drill head penetrates about 12 – 18 inches into the ground, while keeping drilling fluid running.
14. With joystick rotate (clockwise) and thrust drill head forward until spindle forward thrust comes to a stop.
15. Switch drill fluid to off position.

4. Drilling Operation

1. Switch drill fluid toggle to auto (Figure 42).
2. Switch Head Cushion to ON position (Figure 43).

Figure 42. Switch Drill Fluid Toggle to Auto

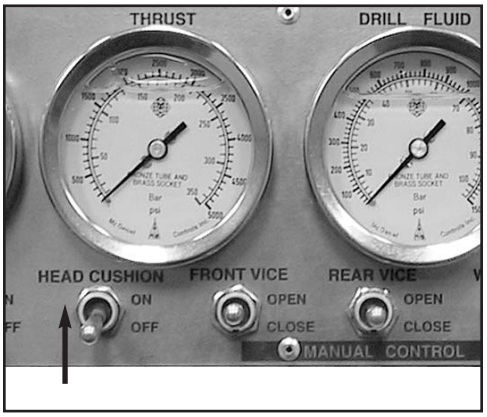


Figure 43. Switch Head Cushion to ON Position

3. Switch auto vice selector in the Smart Vice to drill out (Figure 44).
4. Press the Smart Vice cycle button on joystick to close front vice.
5. Unscrew spindle head from stem by counter rotating the spindle by pulling back on the joystick.
6. Once spindle is completely unscrewed from the stem, pull the joystick to the left and thrust spindle drive into head cushion, this action then places spindle drive into the beginning position.
7. Place next drill stem into position (Figure 45).

Figure 44. Switch Auto Vice Selector in the Smart Vice to Drill Out

Figure 45. Place Next Drill Stem into Position

8. Rotate spindle head and thrust forward until stem is tightened between head and previous stem.
9. Hit Smart Vice cycle button (Figure 46) (This will release front vice and turn bentonite fluid on).
10. At this point you can thrust in for steering or rotate for straight boring.
11. Run stem in until spindle head hits the forward stop.
12. Repeat steps 4-11 until exit location is reached.

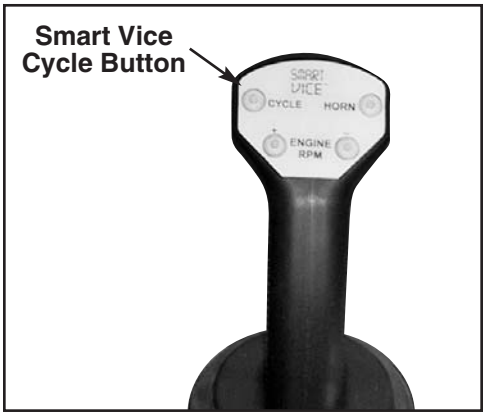


Figure 46. Hit Smart Vice Cycle Button

5. Pre-reaming / Back-reaming

When the bore head reaches the target location and the sonde housing is exposed, a change of tooling is required.

Note: Shut off boring rig before making any tooling changes.

Danger: Stay away from any turning, stem contact may and can cause injury or death.

If the pilot bore is larger than the product pipe, remove the sonde housing and replace with a swiveled piping eye for back pull.

When the pilot bore needs to be expanded to a larger diameter than that of the pilot bore, a change of tooling is than required. The sonde housing is exchanged for a backreamer.

When all tooling is changed and all personnel are clear of the tooling attachment, start engine of bore rig.

1. Bentonite system must be running and connected.
2. Drill Fluid switch needs to be in auto position.
3. Flip auto vice select to the pull back position.
4. Cycle Smart Vice™ button by pressing four times, until both vices are open, and bentonite fluid is flowing (Figure 47).
5. Using the joystick rotate clockwise and thrust in drill stem until spindle hits the head cushion (Figure 48).

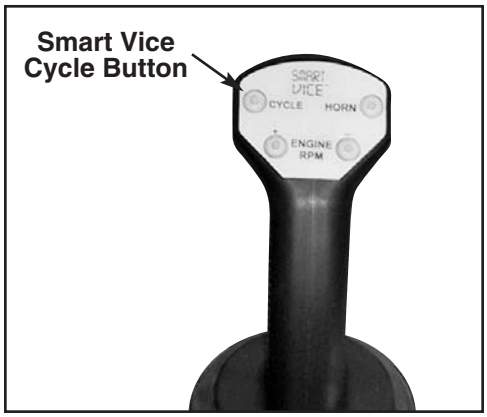


Figure 47. Cycle Smart Vice Button by Pressing Four Times

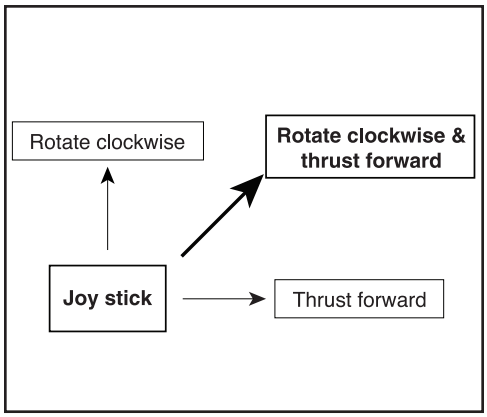


Figure 48. Using Joystick Rotate Clockwise and Thrust in Drill Stem

6. Press the Smart Vice™ cycle button (Figure 49). (Causing front vice to lock, shut bentonite off, rear wrench will lock and break stem joint and then release.)
7. Counter rotate and thrust back about a 1/2" to disengage stems (Figure 50).

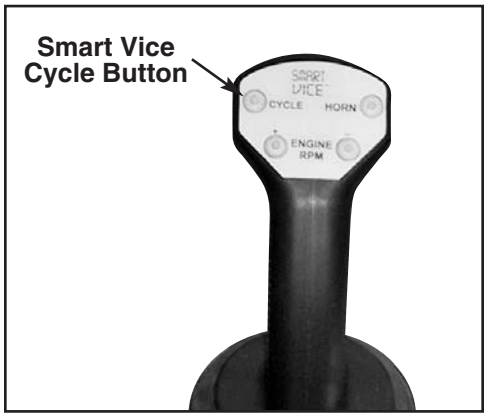


Figure 49. Press the Smart Vice Cycle Button

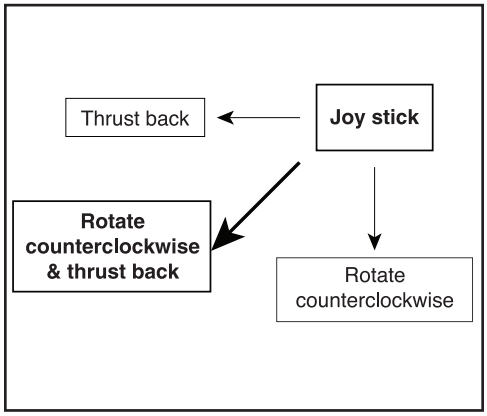


Figure 50. Counter Rotate and Thrust Back 1/2" to Disengage Stems

8. Press the Smart Vice™ cycle button. (Wrench vice closes) (Figure 51).
9. Using joystick counter rotate and thrust back spindle till stops make contact.
10. Press the Smart Vice™ cycle button. (Opens wrench vice) (Figure 52).

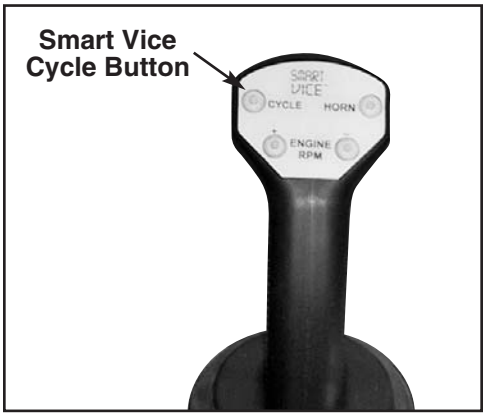


Figure 51. Press the Smart Vice Cycle Button, Wrench Vice Closes

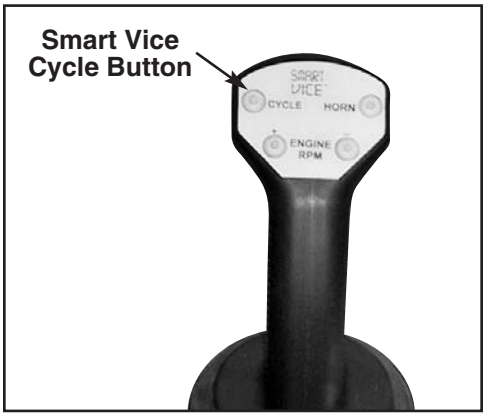


Figure 52. Press the Smart Vice Cycle Button, Opens Wrench Vice

11. Remove stem and place in stem carrier (Figure 53).
12. Thrust spindle forward until it makes contact with next stem, then rotate and thrust till spindle is set into stem (Figure 54).

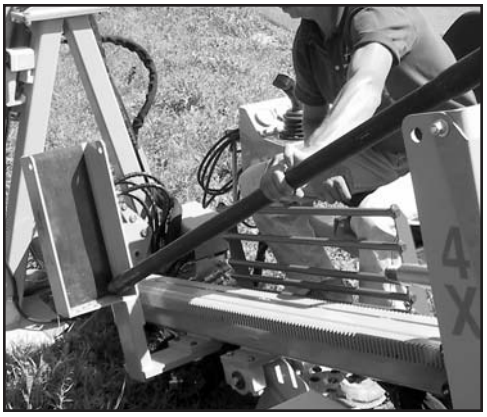


Figure 53. Remove Stem and Place in Stem Carrier

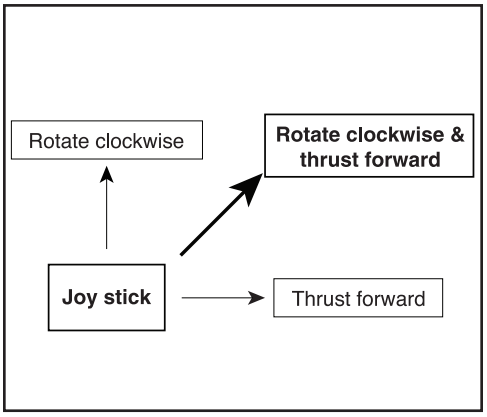


Figure 54. Thrust Spindle Forward, Rotate and Thrust Till Spindle is Set

13. Press the Smart Vice cycle button. (Releases front vice) (Figure 55).
14. Repeat steps 5 – 14 until back reaming is complete.

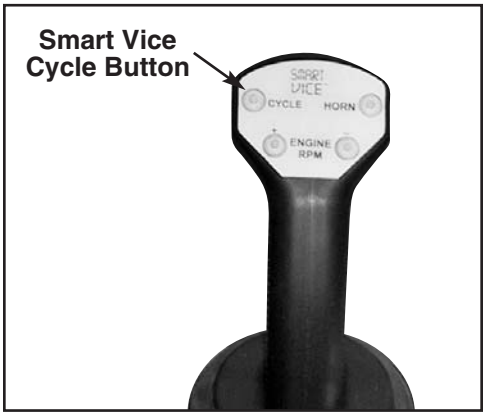


Figure 55. Press the Smart Vice Cycle Button, Releases Front Vice

Trouble Shooting

8.

A. TROUBLE SHOOTING

Observation	Reason	Solution
1. Complete machine shutdown. (Includes no indicator lights)	a) F1 fuse failed. b) F2 fuse failed. c) The battery is discharged. d) Check battery cable connections, check for failed wire or connector.	a) Replace the F1 fuse. b) Replace the F2 fuse. c) Charge/replace the battery. d) Tighten and replace if damaged.
2. Engine doesn't crank.	a) Check corrections above. b) Failed ignition switch. c) Failed K5 (control relay). d) Failed wire or connector.	a) See solutions above. b) Replace ignition switch. c) Replace K5 (control relay). d) Replace wire or connector.
3. Engine cranks but won't start.	a) Check the emergency stop buttons. b) Check diesel fuel level. c) Fuel filter plugged. d) F3 fuse failed. e) Failed K3 (control relay).	a) Make sure the emergency stop button isn't pushed. b) Add diesel fuel if needed. c) Replace Fuel filter. d) Replace F3 fuse. e) Replace K3 (control relay). f) See engine cranks but smokes section.
4. Engine starts and then stops.	a) The engine protection device is active. (The engine is overheated or the engine has no oil pressure). b) The fuel filter is restricted.	a) Let the engine cool, and make sure it has the correct oil pressure. b) Replace the fuel filter.
5. Engine lacks power.	a) The fuel filter is restricted. b) The air filter is restricted. c) Check fuel hoses for leaks. d) The fuel pump is faulty.	a) Replace the fuel filters. b) Replace the air filter. c) Replace damaged hoses. d) Replace the fuel pump.
6. Engine overheats.	a) Radiator air inlet restricted. b) Operating above pressure spec.	a) Clean radiator air inlet area. Let engine cool. Check coolant level. b) Make sure to operate within the pressure specs. (Thrust 3600 PSI) (Rotation 4200 PSI)

Observation	Reason	Solution
7. Engine cranks but smokes excessively at cold startup or won't start.	a) Check for high quality and grade of fuel. b) Operator not using Glow Plugs. c) One or more glow plugs failed. d) Key switch failed. e) K2 (control relay) failed. f) Basic engine problem.	a) Use high quality and grade of fuel. b) Use Glow Plugs for cold startup. c) Replace glow plugs. d) Replace Key switch. e) Replace K2 (control relay). f) Repair engine problem.
8. No Hydraulic and hydrostatic operation.	a) Check for oil in the tank. b) Check the suction screen for damage. c) Check the suction hose for damage. d) Failed pump drive. e) Failed hydraulic pump drive coupler.	a) Put oil in the tank. b) Replace the suction screen if necessary. c) Replace the suction hose if damaged. d) Replace pump drive. e) Replace hydraulic pump drive coupler.
9. Hydraulic light comes on.	a) Ambient temperature below 40°F. b) Hydraulic filter is restricted. c) Wrong hydraulic oil was used.	a) Run engine at low idle speed to warm hydraulic oil. b) Replace the hydraulic filter. c) Use proper Hydraulic oil (Dextron III).
10. Thrust and rotation fail to work or work slowly.	a) Probable loss of charge pressure. b) Check for braided lines that are damaged. c) Does the vice work correctly? No indicates a hydraulic pump failure. e) *Pressure less than 300 PSI. Check the two charge relief valves in the Hydrostatic pumps. Check the charge regulating valve in the Hot oil shuttle manifold. Failed hydrostatic pump assembly. Failed hot oil shuttle valve. f) *Pressure at or above 300 PSI. Failed joy stick control.	a) Maintain charge pressure. b) Replace braided lines that are damaged. c) Replace hydraulic pump. Install test gauge. Run engine at low speed. e) Replace the two charge relief valves in the Hydrostatic pumps. Replace the charge regulating valve in the Hot oil shuttle manifold. Replace hydrostatic pump assembly. Replace hot oil shuttle valve. f) Replace joy stick control.
11. Thrust or rotation fail to work or work slowly.	a) Failed high pressure relief valve on associated function. b) Failed hydrostatic motor in the failed circuit. c) Failed hot oil shuttle valve in failed circuit. d) Failed joystick control. e) Failed hydrostatic pump.	a) Replace high pressure relief valve on associated function. b) Replace hydrostatic motor in the failed circuit. c) Replace hot oil shuttle valve in failed circuit. d) Replace joystick control. e) Replace hydrostatic pump.

Observation	Reason	Solution
12. All hydraulic functions fail to work. Except the vice and tracks. NOTE: Functions will work if you hold a manual operation vice function simultaneously.	a) Failed Hydraulic solenoid one (dump valve). b) Failed relief valve no. one. c) Failed hydraulic pump no. one. d) Failed wire or connection.	a) Replace Hydraulic solenoid one (dump valve). b) Replace relief valve no. one. c) Replace hydraulic pump no. one. d) Replace wire or connection.
13. All hydraulic functions work except the vice is slow and the tracks only have low speed.	a) Failed hydraulic solenoid two (dump valve). b) Failed relief valve no. two. c) Failed hydraulic pump no. two. d) Failed wire or connection.	a) Replace hydraulic solenoid two (dump valve). b) Replace relief valve no. two. c) Replace hydraulic pump no. two. d) Replace wire or connection.
14. Any independent hydraulic function doesn't work. Boom, stabilizer, etc.	a) Failure of the associated switch. b) Failure of the associated hydraulic solenoid valve. c) Failed wire or connector.	a) Replace the associated switch. b) Replace the associated hydraulic solenoid valve. c) Replace wire or connector.
15. The automatic vice doesn't work (Smart Vice).	a) The Mode selector switch is set to manual operation. b) The operator isn't using the cycle button correctly. c) F- fuse failed. d) Hydraulic system failure. e) Failed wire or connector. f) The jaws are worn.	a) Set the Mode selector switch to On for Smart Vice operation. b) Make sure the operator is using the cycle button correctly. c) Replace F- fuse. d) Check sections titled: "All hydraulic functions fail" "All hydraulic functions work" "Any independent hydraulic function" e) Replace wire or connector. f) Replace the jaws.
16. The work light doesn't work.	a) The light element failed-replace. b) F- fuse failed-replace. c) The switch failed-replace. d) Failed K- relay-replace. e) Failed wire or connector.	a) Replace the light element. b) Replace F- fuse. c) Replace the switch. d) Replace K- relay. e) Replace wire or connector.
17. The strobe light doesn't work.	a) The strobe element failed. b) F- fuse failed-replace. c) The switch failed-replace. d) Failed wire or connector.	a) Replace the strobe element. b) Replace F- fuse. c) Replace the switch. d) Replace wire or connector.
18. The horn doesn't work	a) The horn failed-replace. b) F- fuse failed-replace. c) Failed K- relay-replace. d) The horn switch failed-replace. e) Failed wire or connector.	a) Replace the horn. b) Replace F- fuse. c) Replace K- relay. d) Replace the horn switch. e) Replace wire or connector.

Warranty Information

9.

DISCLAIMER FOR STEERABLE BORING MANUAL: NO WARRANTY AS TO MANUAL

TT Technologies makes no warranty that the information provided in this manual is complete, accurate in all respects, or up to date. This manual should be used as a reference work to provide a starting point for addressing steerable boring situations. Each particular situation is different. The user is responsible for providing the expertise and skill necessary to properly execute a given steerable boring job. TT Technologies specifically disclaims all express or implied warranties concerning this manual, including the implied warranties of merchantability and fitness. In no event shall TT Technologies be liable for consequential, special or incidental damages or contingent liabilities (including, without limitation, lost profits or goodwill, whether such claim arises in tort, contract, negligence, strict liability or any other basis) arising in any way out of the use of this manual.

LIMITED WARRANTY AS TO PRODUCTS

TT provides a limited warranty to the original purchaser of its new products that new products will be free from defects in materials and workmanship for 90 days or 500 hours of actual use, whichever occurs first, provided they are properly maintained serviced and used for the intended purpose of the product. During the 90 day or 500 hours period, buyer's remedies are limited to repair or replacement, at TT Technologies' discretion.

TT Technologies makes no other warranty, express or implied, and makes no warranty of merchantability or fitness for any particular purpose. No person, representative or agent of TT Technologies has the authority to change this warranty in any manner whatsoever. Any oral or written statements inconsistent with this limited warranty shall not apply.

In no event shall TT Technologies be liable for consequential, special or incidental damages or contingent liabilities (including, without limitation, lost profits or goodwill, whether such claim arises in tort, contract, negligence, strict liability or any other basis) arising in any way out of the use of any product or any parts thereof.

Maintenance

10. A. SERVICE INTERVALS

Item	Daily	Weekly	Annually
Clean Bore Rig.	X		
Check hydraulic hoses and electrical cables for tightness and correct seating.	X		
Check and clean the jet nozzle of the bore head, back reamers, accessories and tooling before starting.	X		
Check strike alert system and make sure safety equipment is functioning properly.	X		
Check fuel tank level. (Use No. 2 diesel above 32°F. Use No. 1 diesel below 32°F.)	X		
Check the engine oil level.	X		
Check the engine coolant level.	X		
Grease drill stem thread, use copper antiseize lube as required.	X		
Grease carriage rollers.	X		
Check that ventilation is clear of foreign material and debris for the radiator and oil cooler.	X		
Check drill head rollers and lubricate with a general purpose lithium based grease NLGI2.	X		
Check drill head guides for excessive side movement of drill head.	X		
Check the drill stem guide for wear.	X		
Check thrust gear lube, use a dry lube containing Molybdemum disulfide "Moly".	X		
Check for leaks on drill head drive 80-90 gear lube.	X		
Check for leaks on track final drive units 80-90 gear lube.	X		
Check hydraulic oil level, use automatic transmission fluid Dextron III.	X		
Check the vice and wrench jaws for wear.	X		
Change engine oil after 1st 50 hours of use.		X (50 hrs)	
Check the wear on the drive track.		X	
Check the track tension, 1/2" sag. Use general purpose lithium based grease NLGI2 as required		X	
Check all indicator lights and gauges of the operation panel.		X	
Change engine oil every 200 hours thereafter or anually.			X (200 hrs)
Change fuel filter and strainer annually or 400 hours.			X (400 hrs)
Change antifreeze solution annually or 500 hours.			X (500 hrs)
Change hydraulic oil annually or at 500 hours.			X (500 hrs)
Change filter and clean screen annually or at 500 hours.			X (500 hrs)
Change filter if service lamp indicates.			X (when lit)
Change drill head assembly 80-90 gear lube.			X
Change under carriage drive units 80-90 gear lube.			X
Change spindle drive oil.			X
Change under carriage drive oil.			X

B. LUBRICATION PRODUCTS AND OIL TABLE

Item	Type	Quantity	Intervals
Drill Head Rollers	General Purpose Lithium Based Grease NLGI2		Daily
Drill Stem Thread	Copper Antiseize Lube		Daily
Thrust Gear Lube	Dry Lube Containing Molybdemum disulfide "Moly"		Daily
Fuel - No. 2 Diesel above 32° F No. 1 Diesel below 32° F	Diesel	10 Gallons	Daily
Track Tensioner	General Purpose Lithium Based Grease NLGI2	1/2" Sag	Weekly
Boring Rig Hydraulic Oil	Automatic Transmission Fluid Dextron III	18 Gallons	Annually
Drill Head Assembly	80-90 gear lube	1 Quart	Annually
Under Carriage Drive	80-90 gear lube	1/2 Quart	Annually
Engine Oil above 25° C (77° F) 0-25° C (32-77° F) below 0° C (32° F)	API Classification CD Grades or Higher SAE 30, SAE10W-30, SAE10W-40 SAE 20, SAE10W-30, SAE10W-40 SAE 10W, SAE10W-30, SAE10W-40	6.0 L (1.59 Gal.)	200 Hrs. or Annually
Coolant	Ethylene Glycol Mixed with Water, Free of Minerals, 50%/50% Vol. % Freezing-Boiling 50 (-37 to 180° C, -34 to 226° F)	4.0 L (1.06 Gal.)	500 Hrs. or Annually

C. JAW REMOVAL AND REPLACEMENT

1. Start Grundodrill 4X drill and close both of the front and rear jaws.
2. Turn machine off.
3. Remove rod wiper by turning and pulling outward (Figure 56).
4. Starting with the vice assembly remove lynch pins to remove jaw pins (Figure 57).

Figure 56. Remove Rod Wiper

Figure 57. Remove Lynch Pins

5. After removing both lynch pins, pull front pins out (Figure 58).
6. After the pins are removed slide jaw assembly to the left or to the right to align jaw for removal (Figure 59).

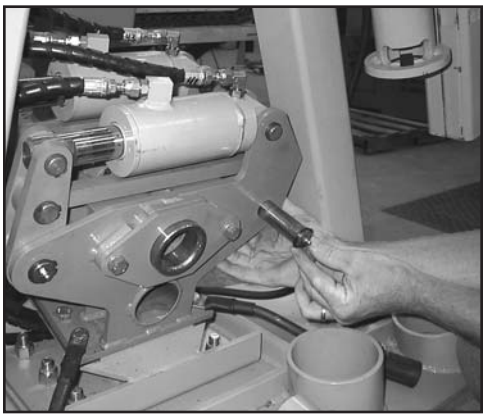


Figure 58. Pull Front Pins Out

Figure 59. Slide Jaw Assembly to Align for Jaw Removal

7. Pull jaw out (Figure 60) and replace with new (Figure 61). There are two jaws in each jaw assembly, after they have been replaced, insert pins and lynch pins. Repeat the process for changing the jaws in the rear vice.

Figure 60. Pull Jaw Out

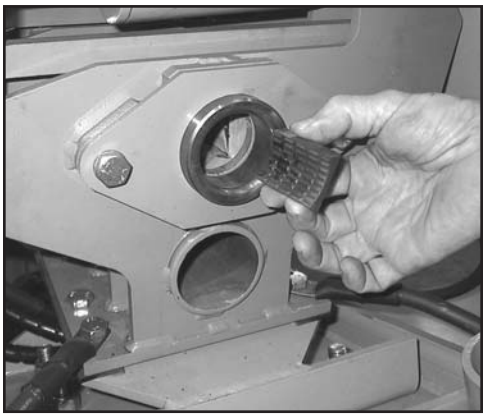
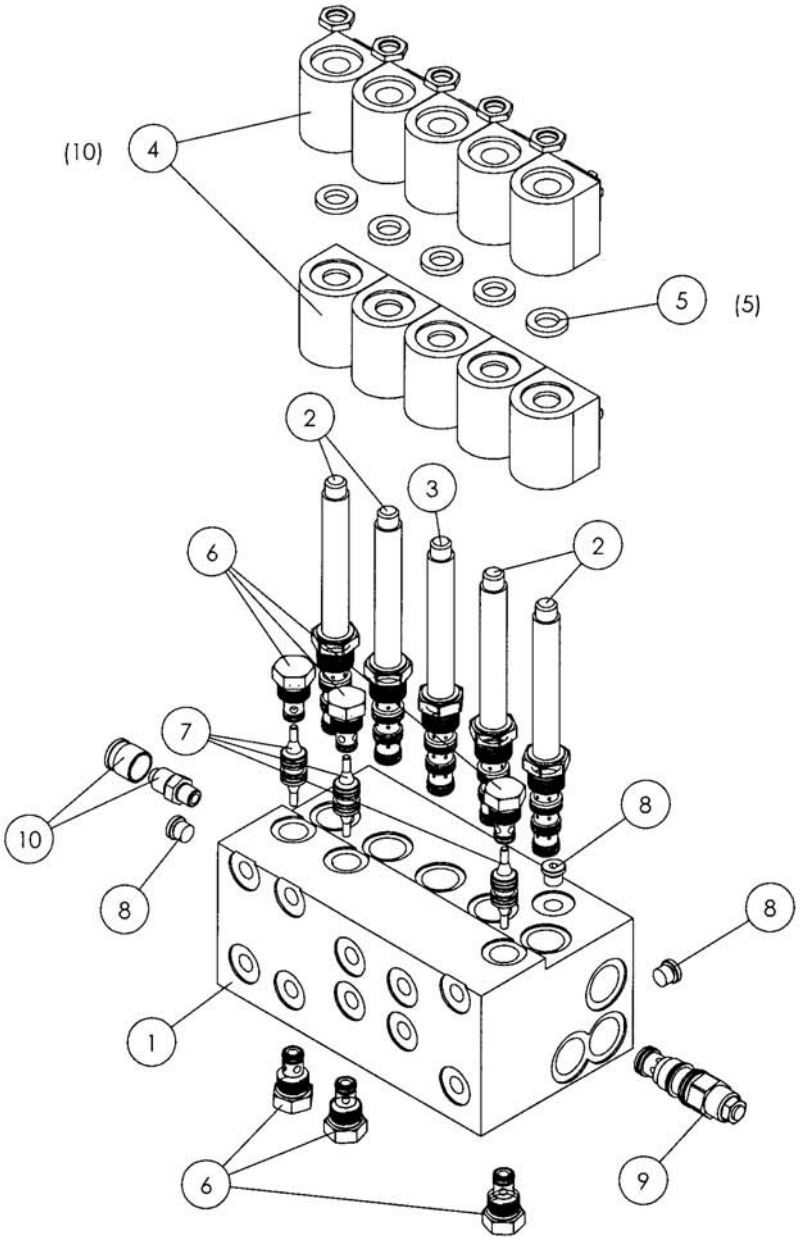


Figure 61. Replace With New Jaw

Appendices

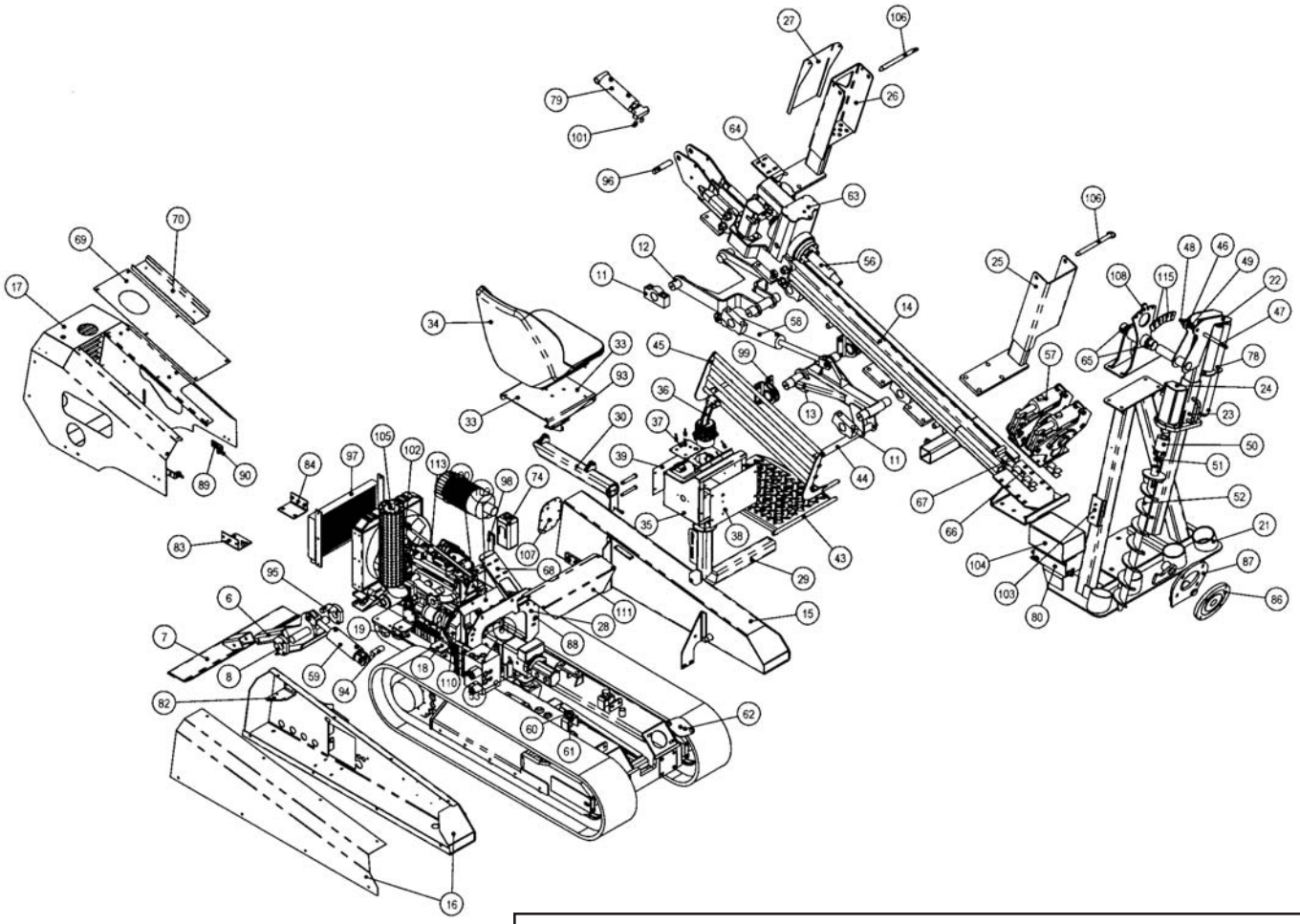
A. 4X GRUNDODRILL VISE CONTROL BLOCK

11.



ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	wrench valve manifold	BLOCK, VISE CONTROL
2	4	DG-S4P-00	VALVE
3	1	DG-S4M-00	VALVE
4	10	HC12	COIL
5	5	SPACER	SPACER
6	6	MA-CVA-00-0005-X	CHECK VALVE
7	3	70133805	PILOT PISTON
8	3	PLUG	PLUG
9	1	RPEC-LAN	PRESSURE RELIEF VALVE
10	1	EMA3-7-16-20UNF-2A	TEST PORT
11	1	DG-S4P-00-HC12	VALVE ASSEMBLY - DG-S4P-00 (1EA.) & HC12 (2EA.)
12	1	DG-S4M-00-HC12	VALVE ASSEMBLY - DG-S4M-00 (1EA.) & HC12 (2EA.)

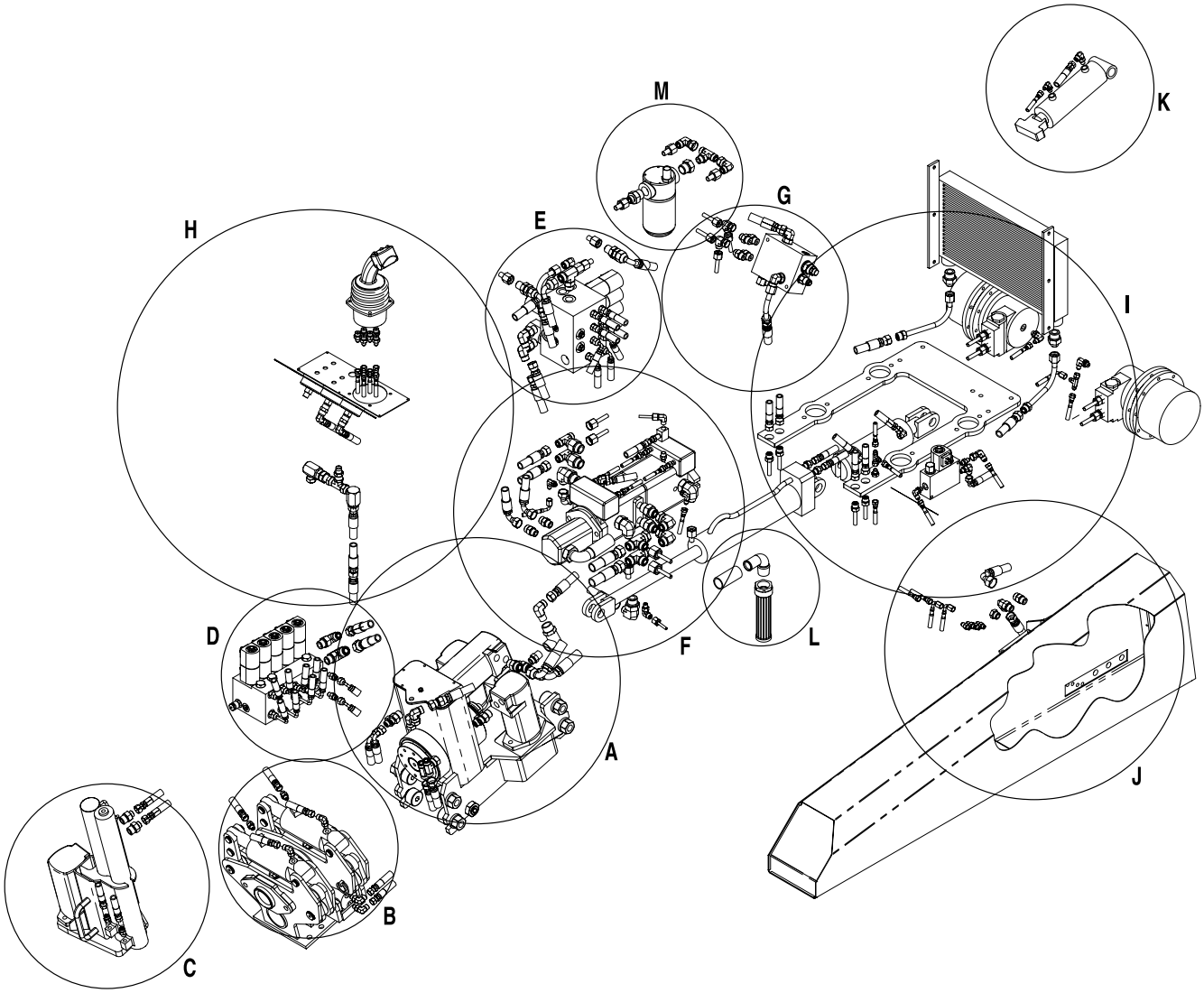
B. 4X GRUNDODRILL OVERALL ASSEMBLY



ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	DRI-U-10233	4X UNDERCARRIAGE
2	2	MU1510	IDLER ASSEMBLY
3	2	MU1531_38_230	TRACK
4	1	CS297	VALVE KIT, 4X IDLER
5	10	MU1503	ROLLER
6	1	DRI-U-10222	ARM, REAR STABILIZER
7	1	DRI-U-10212	PAD, REAR STABILIZER
8	2	DRI-U-10139	PLATE, BEARING - REAR STABILIZER
9	2	DRI-U-20000	TRACK DRIVE MOTOR
10	2	DRI-U-10321	SPROCKET
11	6	DRI-U-10247	BEARING BLOCK
12	1	DRI-U-10208	LINKAGE ARM, UPPER
13	1	DRI-U-10207	LINKAGE ARM, LOWER
14	1	DRI-U-10232	BOOM, 4X (5' STEM)
15	1	DRI-U-10220	HYDRAULIC RESERVOIR
16	1	DRI-U-10217	COMPARTMENT ASSEMBLY
17	1	DRI-U-10257	ENCLOSURE BODY
18	4	DRI-U-10137	ANGLE, ENGINE MOUNT
19	5	507-3	ISOLATOR, ENGINE #507-3
20	1	V1505-B1	ENGINE/PUMP ASSEMBLY
21	1	DRI-U-10211	PLATE, STAKE DOWN
22	1	DRI-U-10210	GUIDE
23	1	DRI-U-10213	SLIDE FRAME
24	1	DRI-U-10224	MOTOR, THRUST - 4X
25	1	DRI-U-10204	ROD BRACKET, LOWER
26	1	DRI-U-10203	ROD BRACKET, UPPER
27	1	DRI-U-10371	PANEL, ROD LUBE
28	1	DRI-U-10354	PLATE, BULKHEAD
29	1	DRI-U-10238	CONSOLE FRAME
30	1	DRI-U-10239	SEAT SUPPORT
31	1	shcs375X100	SHCS, 3/8-16 X 1.00"
32	1	92390A399	PIN - CARR LANE# 92390A399
33	1	DRI-U-10092	PLATE, SEAT
34	1	DRI-U-10226	SEAT
35	1	DRI-U-10231	ENCLOSURE, CONSOLE
36	1	DRI-U-20030	JOY STICK CONTROLLER

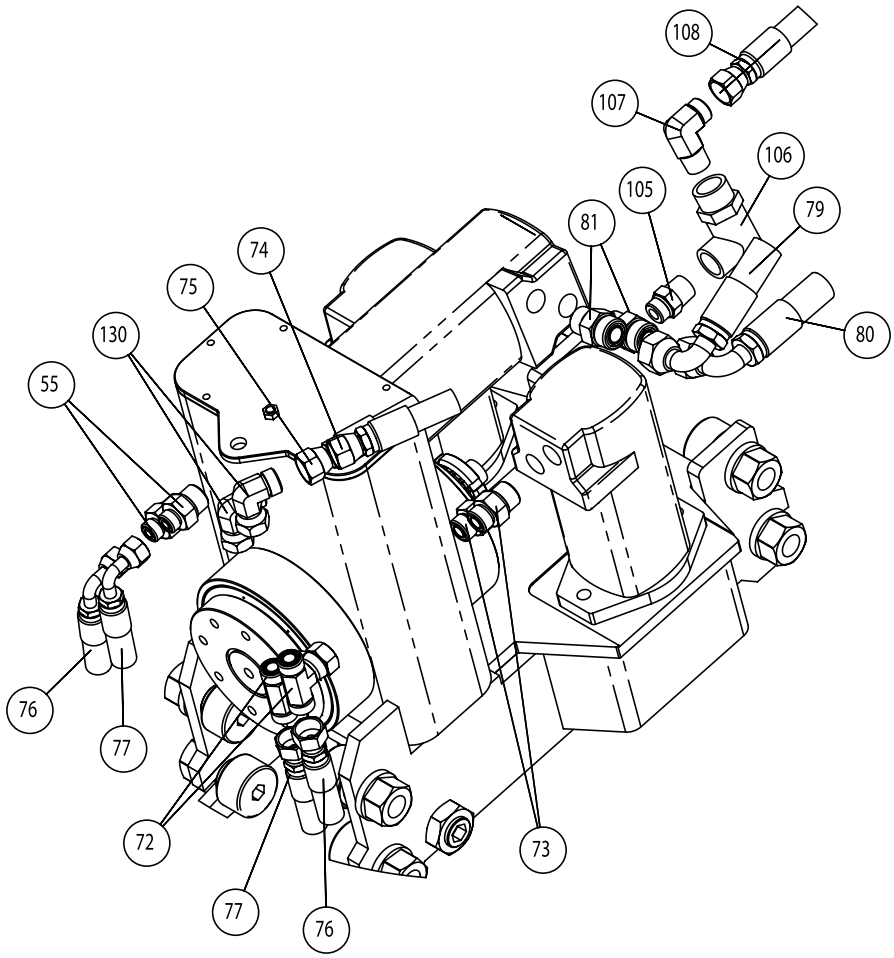
ITEM NO.	QTY.	PART NO.	DESCRIPTION
37	1	DRI-U-10347	PANEL
38	1	DRI-U-10180	PLATE, COVER (WIDE)
39	1	DRI-U-10179	PLATE, COVER (NARROW)
40	10	SWITCH	SWITCH
41	3	GAUGE	GAUGE
42	1	98306A510	PIN - CARR LANE# 98306A510
43	1	DRI-U-10241	PLATFORM
44	1	DRI-U-10361	TUBE, PLATFORM SUPPORT
45	1	DRI-U-10242	BARRIER
46	1	98025A035	WASHER - CARR LANE# 98025A035
47	1	DRI-U-10446	PIN, STAKE DOWN STOP
48	1	92383A358	ROLL PIN, 3/16 X 1.00"
49	1	C0850-068-3500	SPRING - ASSOCIATED SPRING # C0850-068-350
50	1	DRI-U-10138	CHUCK, STAKE DOWN AUGER
51	1	DRI-U-10141	WASHER, RETAINER
52	1	DRI-U-10221	STAKE, HOLD DOWN
53	1	DRI-U-10310	PUMP SUPPORT (BONDIOLI)
54	1	DRI-U-10185	BRACKET, FUEL FILTER
55	1	DRI-U-10184	BRACKET, ZINGA FILTER
56	1	DRI-U-10237	SPINDLE
57	1	DRI-U-10243	POWER WRENCH
58	1	DRI-U-10389	CYLINDER, BOOM LIFT
59	1	DRI-U-10390	CYLINDER, REAR STABILIZER
60	2	hhcsm24x3x70	HHCS, M24 X 3 X 70mm
61	2	nutjamM24.PRT	JAM NUT, M24x3
62	1	DRI-U-10250	COVER, CLEANOUT
63	1	DRI-U-10251	DRILL HEAD ASSEMBLY
64	1	DRI-U-10411	BRACKET, POWER TRACK (DRILL HEAD)
65	2	PF2832-16	BEARING - POLYGON# PGP 2832-16
66	2	DRI-U-10428	SHIM - 16 GA.
67	2	DRI-U-10427	SHIM - 11 GA.
68	1	DRI-U-10258	FIXED BRACKET, POWER TRACK
69	1	DRI-U-10436	PANEL, ACCESS
70	1	DRI-U-10437	CHANNEL, POWER TRACK
71	4	nut312	NUT, 5/16-18 UNC
72	4	DRI-U-10259	COVER BRACKET
73	1	T14BH517BC	HOUR METER - ENM CHICAGO# T14BH517BC.
74	1	RESERVOIR	RESERVOIR, COOLANT LEVEL
75	1	DRI-U-10458	BRACKET, FUEL FILTER
76	1	FUEL PUMP	FUEL PUMP
77	1	FILTER ASSEMBLY	FUEL FILTER ASSEMBLY
78	1	DRI-U-10261	CYLINDER ASSEMBLY, STAKE DOWN
79	1	DRI-U-10262	CYLINDER STOP ASSEMBLY
80	1	DRI-U-22000	VALVE ASSEMBLY, WRENCH
81	1	DRI-U-21000	VALVE ASSEMBLY, PRIMARY (RIGHT ENCLOSURE)
82	1	DRI-U-10466	FILTER BRACKET
83	1	DRI-U-10275	BRACKET, HOOD MOUNT (W/TAB)
84	1	DRI-U-10265	BRACKET, HOOD MOUNT
85	1	DRI-U-10267	LOUVRE PANEL
86	1	DRI-U-10534	ROD WIPER
87	1	DRI-U-10268	BRACKET, ROD WIPER MOUNT
88	2	DRI-U-10535	GROMMET
89	2	DRI-U-10485	BRACKET, LOCATOR PIN
90	2	DRI-U-10486	PIN, LOCATOR
91	4	nut375	NUT, 3/8-16 UNC
92	4	WASHER_375_FLAT	WASHER, 3/8" FLAT
93	1	DRI-U-10270	SEAT STOP
94	1	DRI-U-10497	PIN, CYLINDER
95	1	DRI-U-10496	PIN, CYLINDER
96	1	DRI-U-10498	PIN, CYLINDER
97	1	DRI-U-10272	COOLER WELDMENT
98	1	DRI-U-10269	BRACKET, COOLANT LEVEL
99	2	DRI-U-10273	BEARING BLOCK ASSEMBLY
100	1	DRI-U-10502	PLATE, RADIATOR BRACE
101	2	DRI-U-10490	SLIDE PLUG
102	1	9376K122	ISOLATOR
103	1	DRI-U-10503	CLAMP CHANNEL
104	1	DRI-U-10276	COVER, WRENCH VALVE
105	1	DRI-U-10274	MUFFLER WELDMENT
106	2	98404A790	PIN, RING-GRIP SELF LOCKING 3/4" X 9.00"
107	1	DRI-U-10417	PLATE, ACCESS
108	1	DRI-U-10279	PIVOT WELDMENT
109	1	DRI-U-10266	BRACKET, LOOP FLUSH VALVE
110	1	DRI-U-10532	BELL HOUSING
111	1	DRI-U-10493	COVER
112	2	DRI-U-10538	SHIM
113	1	DRI-U-10501	BRACE ROD
114	1	DRI-U-10280	BRACKET, FUEL PUMP
115	2	DRI-U-10539	PLATE, STOP
116	1	DRI-U-10298	BRACKET, ROD WIPER PLATE

C. 4X GRUNDODRILL SUB-ASSEMBLIES (A-M)



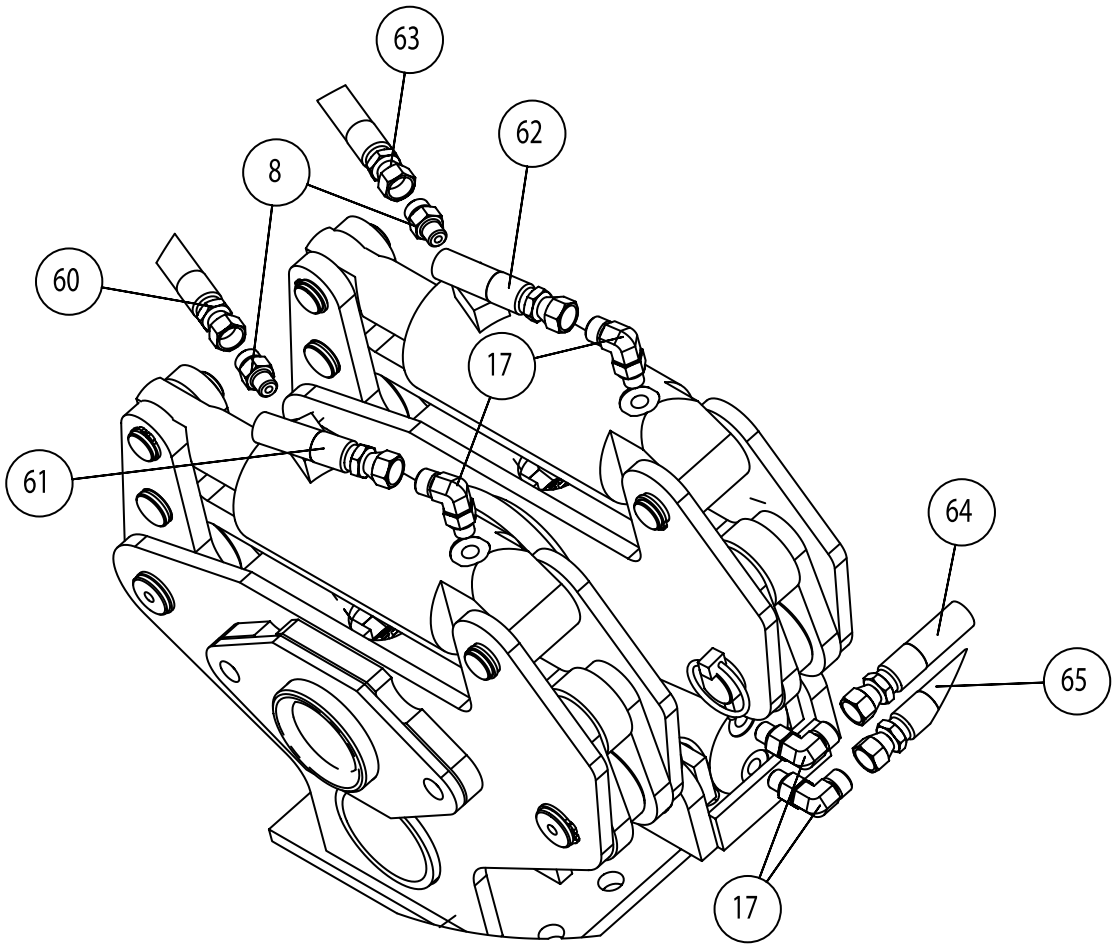
SUB-ASSEMBLY	PAGE
A	39
B	40
C	41
D	42
E	43
F	44
G	46
H	47
I	48
J	50
K	51
L	52
M	53

D. 4X GRUNDODRILL SUB-ASSEMBLY (A)



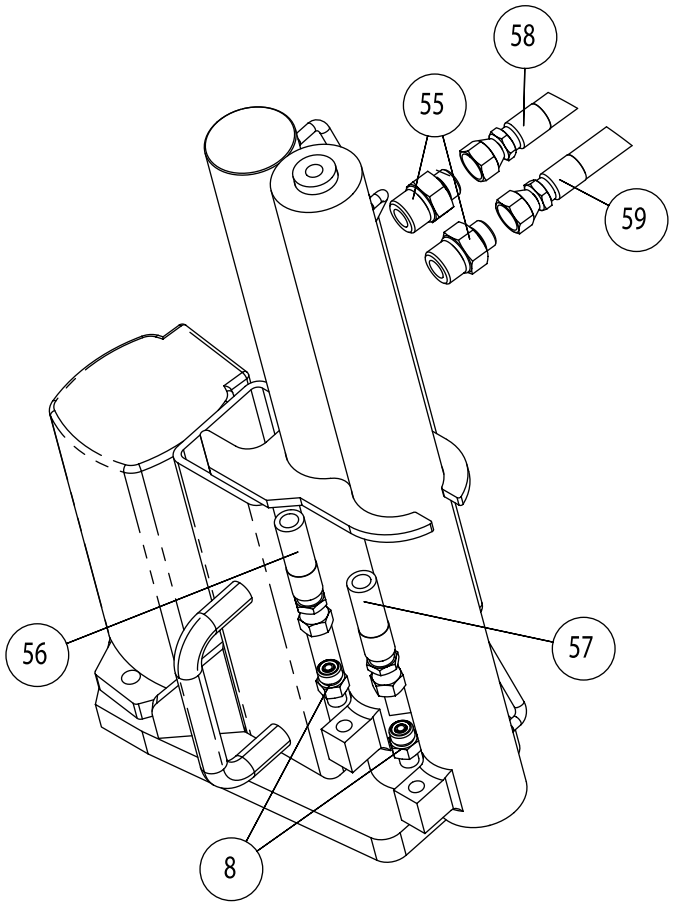
ITEM NO.	QTY.	PART NO.	DESCRIPTION
55	4	FF1852T06010S	FITTING
72	2	FF1857T0808S	FITTING
73	2	FF1852T1008S	FITTING
74	2	DRI-U-10731	HOSE ASSEMBLY
75	2	DRI-U-10732	HOSE ASSEMBLY
76	2	DRI-U-10733	HOSE ASSEMBLY
77	2	DRI-U-10734	HOSE ASSEMBLY
79	2	DRI-U-10735	HOSE ASSEMBLY
80	2	DRI-U-10736	HOSE ASSEMBLY
81	2	FF1852T1010S	FITTING
105	1	8-1_2 F5OF	FITTING
106	1	005-02M02A04B04M11	SWIVEL
107	1	FF2032T0808S	FITTING
108	2	DRI-U-10749	HOSE ASSEMBLY
130	4	FF2098T0808S	FITTING

E. 4X GRUNDODRILL SUB-ASSEMBLY (B)



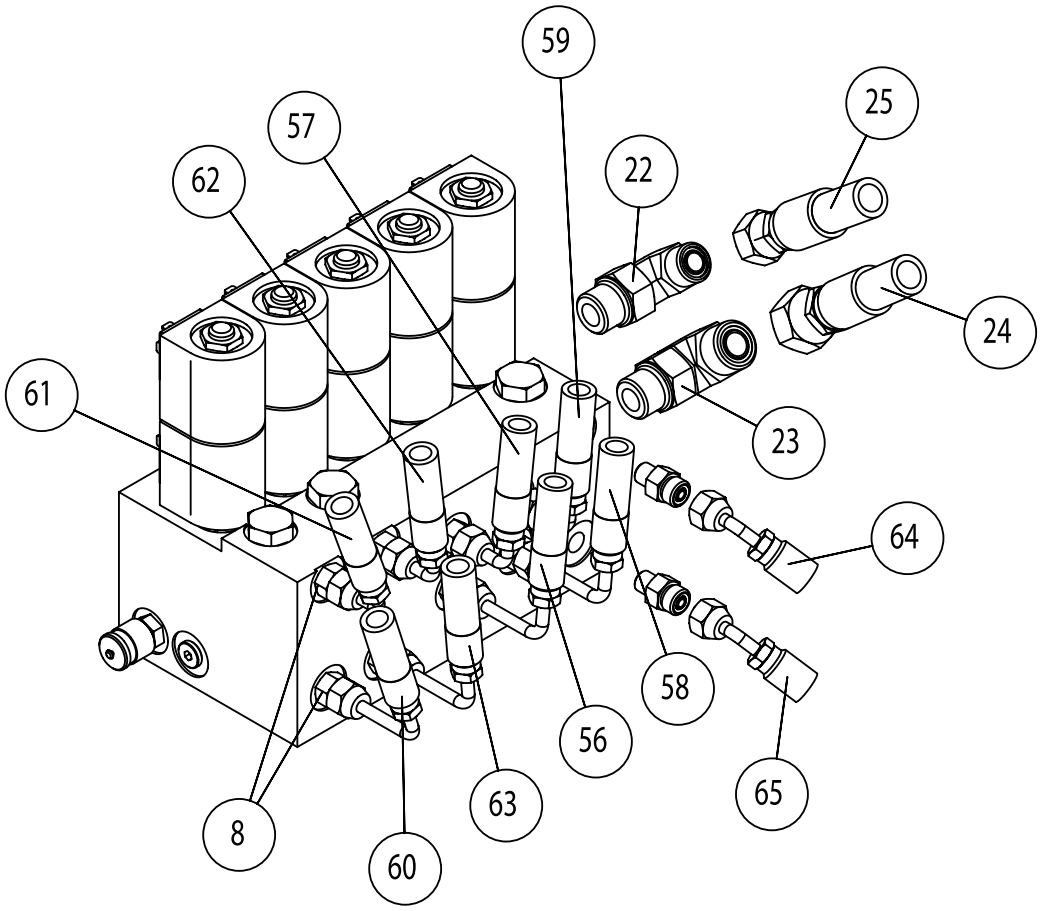
ITEM NO.	QTY.	PART NO.	DESCRIPTION
8	2	FF1852T0404S	FITTING
17	10	FF1868T0404S	FITTING
60	2	DRI-U-10724	HOSE ASSEMBLY
61	2	DRI-U-10723	HOSE ASSEMBLY
62	2	DRI-U-10725	HOSE ASSEMBLY
63	2	DRI-U-10726	HOSE ASSEMBLY
64	2	DRI-U-10727	HOSE ASSEMBLY
65	2	DRI-U-10728	HOSE ASSEMBLY

F. 4X GRUNDODRILL SUB-ASSEMBLY (C)



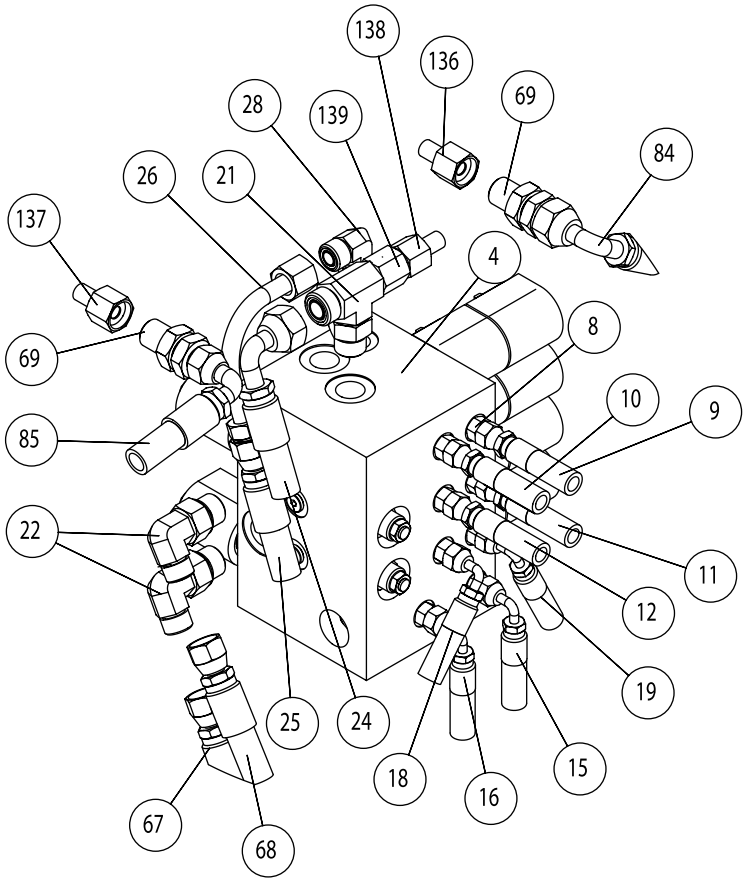
ITEM NO.	QTY.	PART NO.	DESCRIPTION
8	2	FF1852T0404S	FITTING
55	4	FF1852T06010S	HOSE ASSEMBLY
56	2	DRI-U-10719	HOSE ASSEMBLY
57	2	DRI-U-10720	HOSE ASSEMBLY
58	2	DRI-U-10721	HOSE ASSEMBLY
59	2	DRI-U-10722	HOSE ASSEMBLY

G. 4X GRUNDODRILL SUB-ASSEMBLY (D)



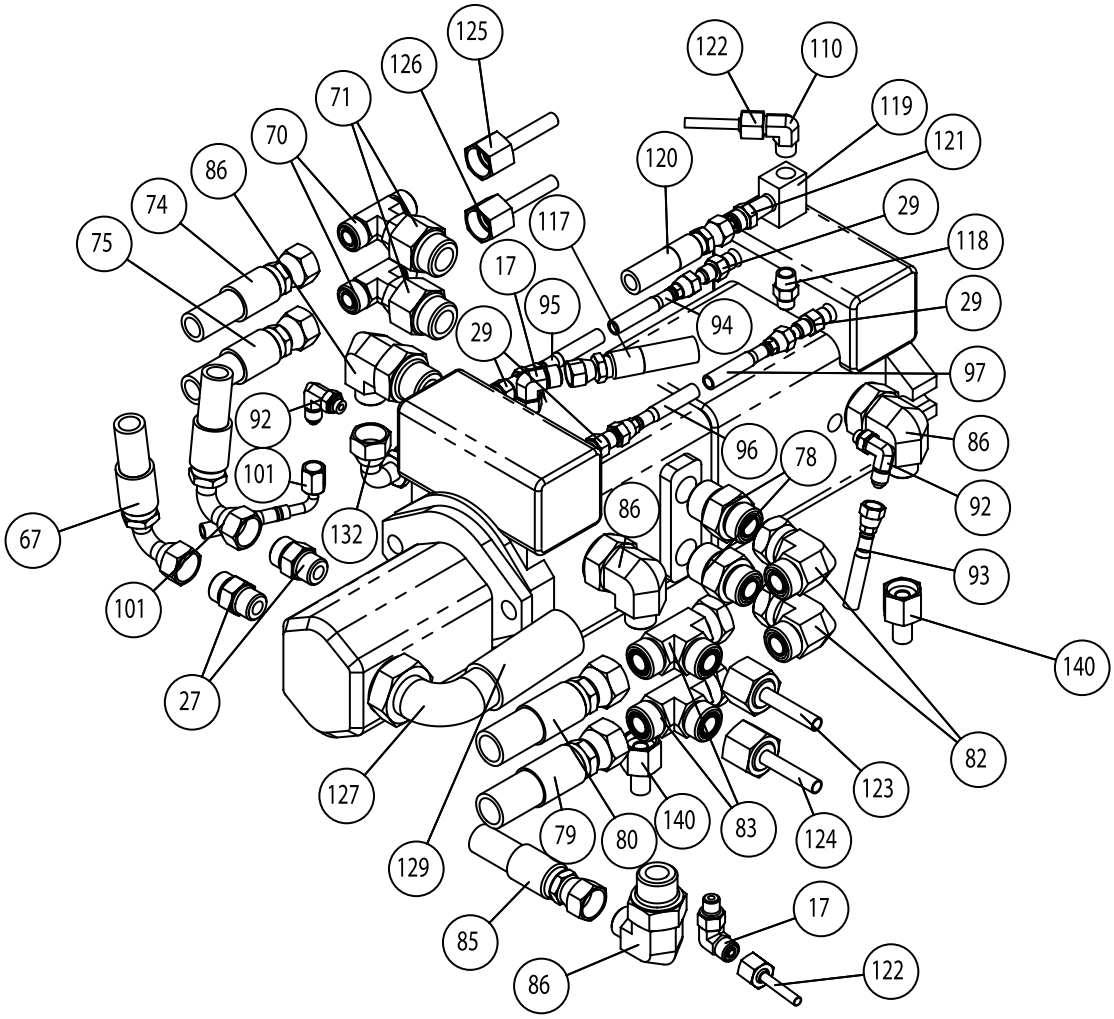
ITEM NO.	QTY.	PART NO.	DESCRIPTION
8	2	FF1852T0404S	FITTING
22	3	FF1868T0810S	FITTING
23	1	FF1868T1010S	FITTING
24	2	DRI-U-10712	HOSE ASSEMBLY
25	2	DRI-U-10711	HOSE ASSEMBLY
56	2	DRI-U-10719	HOSE ASSEMBLY
57	2	DRI-U-10720	HOSE ASSEMBLY
58	2	DRI-U-10721	HOSE ASSEMBLY
59	2	DRI-U-10722	HOSE ASSEMBLY
60	2	DRI-U-10724	HOSE ASSEMBLY
61	2	DRI-U-10723	HOSE ASSEMBLY
62	2	DRI-U-10725	HOSE ASSEMBLY
63	2	DRI-U-10726	HOSE ASSEMBLY
64	2	DRI-U-10727	HOSE ASSEMBLY
65	2	DRI-U-10728	HOSE ASSEMBLY

H. 4X GRUNDODRILL SUB-ASSEMBLY (E)



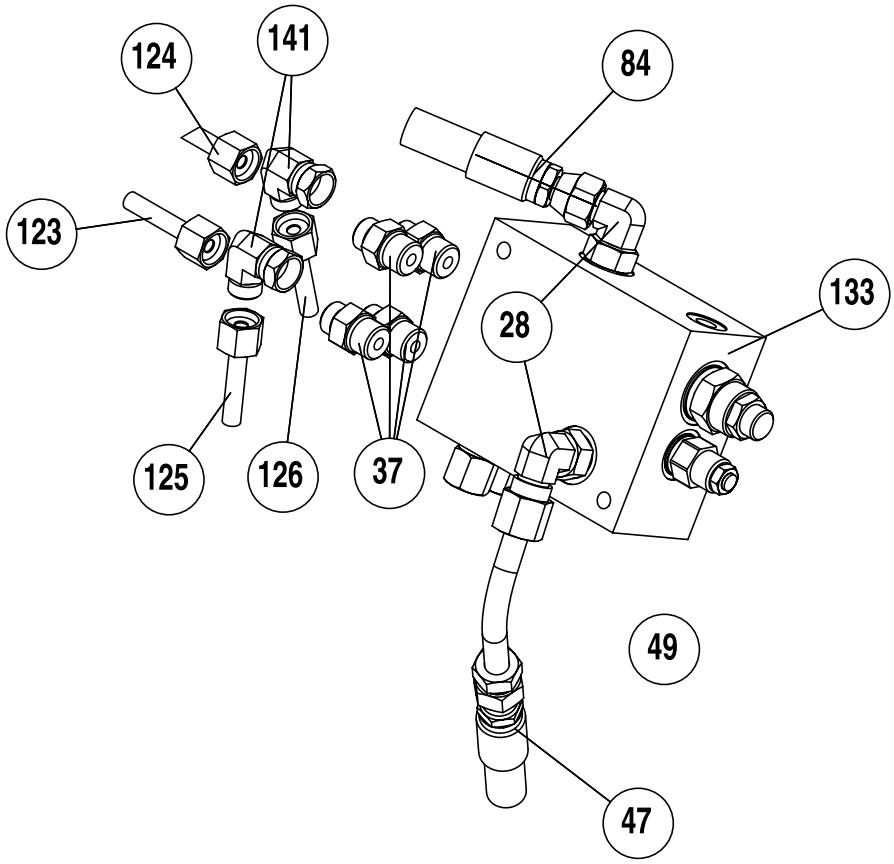
ITEM NO.	QTY.	PART NO.	DESCRIPTION
4	1	DRI-U-21000	VALVE ASSEMBLY, PRIMARY (RIGHT ENCLOSURE)
8	22	FF1852T0404S	FITTING
9	2	DRI-U-10703	HOSE ASSEMBLY
10	2	DRI-U-10704	HOSE ASSEMBLY
11	2	DRI-U-10705	HOSE ASSEMBLY
12	2	DRI-U-10706	HOSE ASSEMBLY
15	2	DRI-U-10707	HOSE ASSEMBLY
16	2	DRI-U-10708	HOSE ASSEMBLY
18	2	DRI-U-10710	HOSE ASSEMBLY
19	2	DRI-U-10709	HOSE ASSEMBLY
21	1	FF1861T1010S	FITTING
22	3	FF1868T0810S	FITTING
24	2	DRI-U-10712	HOSE ASSEMBLY
25	2	DRI-U-10711	HOSE ASSEMBLY
26	1	DRI-U-10801	HYDRAULIC LINE ASSEMBLY
28	4	FF1868T0808S	FITTING
67	2	DRI-U-10729	HOSE ASSEMBLY
68	2	DRI-U-10730	HOSE ASSEMBLY
69	2	FF1994T0808S	FITTING, BULKHEAD
84	2	DRI-U-10737	HOSE ASSEMBLY
85	2	DRI-U-10738	HOSE ASSEMBLY
136	2	DRI-U-10813	HYDRAULIC LINE ASSEMBLY
137	2	DRI-U-10814	HYDRAULIC LINE ASSEMBLY
138	2	DRI-U-10815	HYDRAULIC LINE ASSEMBLY
139	1	FF2281T0810S	FITTING

I. 4X GRUNDODRILL SUB-ASSEMBLY (F)



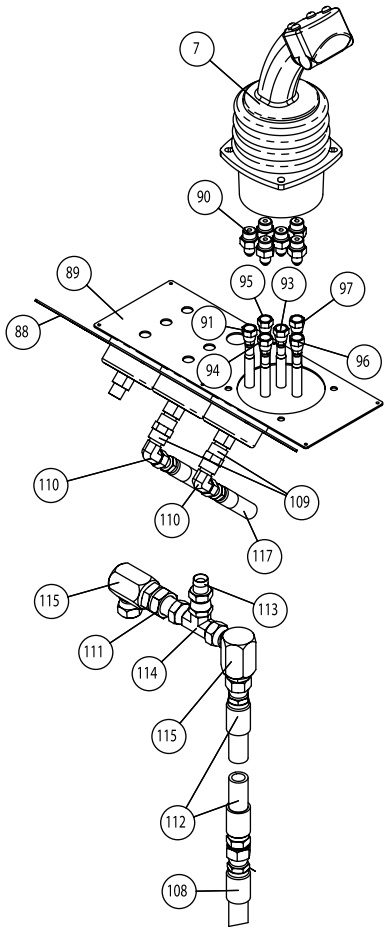
ITEM NO.	QTY.	PART NO.	DESCRIPTION
17	10	FF1868T0404S	FITTING
27	3	FF1852T0808S	FITTING
29	9	202702-4-4s	FITTING
67	2	DRI-U-10729	HOSE ASSEMBLY
70	3	FF1861T0808S	FITTING
71	2	FF1010-1208S	FITTING
74	2	DRI-U-10731	HOSE ASSEMBLY
75	2	DRI-U-10732	HOSE ASSEMBLY
78	2	FF1852T1012S	FITTING
79	2	DRI-U-10735	HOSE ASSEMBLY
80	2	DRI-U-10736	HOSE ASSEMBLY
82	2	FF2098T1010S	FITTING
83	2	FF2114T1010S	FITTING
85	2	DRI-U-10738	HOSE ASSEMBLY
86	4	FF1868T0812S	FITTING
92	2	4C4OMXS	FITTING
93	2	DRI-U-10743	HOSE ASSEMBLY
94	2	DRI-U-10742	HOSE ASSEMBLY
95	2	DRI-U-10741	HOSE ASSEMBLY
96	2	DRI-U-10739	HOSE ASSEMBLY
97	2	DRI-U-10740	HOSE ASSEMBLY
101	2	DRI-U-10745	HOSE ASSEMBLY
110	3	FF2032T0404S	FITTING
117	2	DRI-U-10751	HOSE ASSEMBLY
118	1	4-1_4 F5O5-S	FITTING
119	1	LSVI-2F-N	MANIFOLD BLOCK
120	2	DRI-U-10752	HOSE ASSEMBLY
121	1	FF2031T0404S	FITTING
122	2	DRI-U-10807	HYDRAULIC LINE ASSEMBLY
123	2	DRI-U-10808	HYDRAULIC LINE ASSEMBLY
124	2	DRI-U-10809	HYDRAULIC LINE ASSEMBLY
125	2	DRI-U-10810	HYDRAULIC LINE ASSEMBLY
126	2	DRI-U-10811	HYDRAULIC LINE ASSEMBLY
127	1	4601-16x12	FITTING
129	2	HOSE_16	HOSE
132	2	DRI-U-10753	HOSE ASSEMBLY
140	2	DRI-U-10816	HYDRAULIC LINE ASSEMBLY

J. 4X GRUNDODRILL SUB-ASSEMBLY (G)



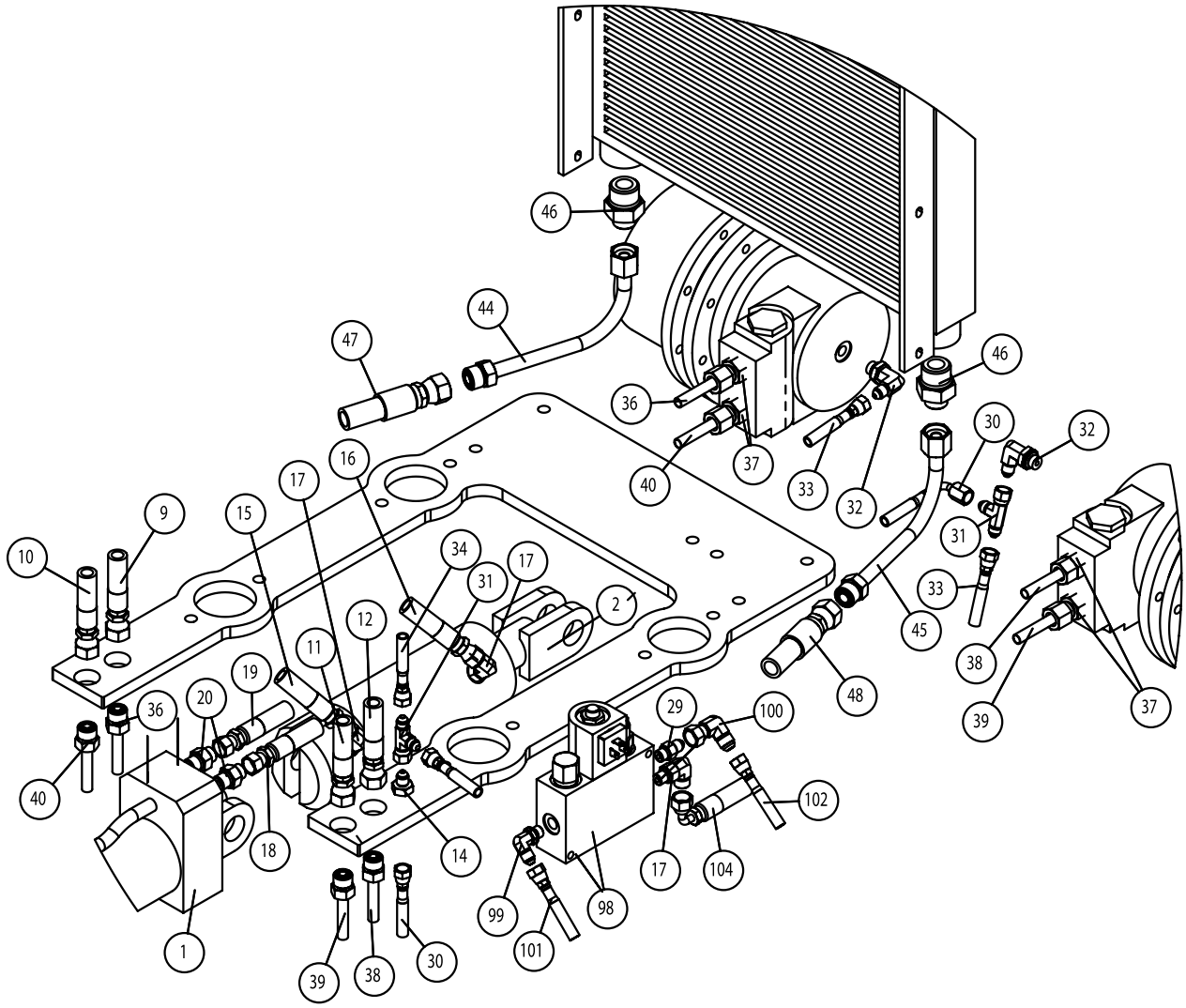
ITEM NO.	QTY.	PART NO.	DESCRIPTION
28	4	FF1868T0808S	FITTING
37	8	FF1852T0608S	FITTING
47	2	DRI-U-10717	HOSE ASSEMBLY
49	1	DRI-U-10806	HYDRAULIC LINE ASSEMBLY
84	2	DRI-U-10737	HOSE ASSEMBLY
123	2	DRI-U-10808	HYDRAULIC LINE ASSEMBLY
124	2	DRI-U-10809	HYDRAULIC LINE ASSEMBLY
125	2	DRI-U-10810	HYDRAULIC LINE ASSEMBLY
126	2	DRI-U-10811	HYDRAULIC LINE ASSEMBLY
133	1	DRI-U-21500	VALVE, HOT OIL SHUTTLE
141	2	FF2098T0606S	FITTING

K. 4X GRUNDODRILL SUB-ASSEMBLY (H)



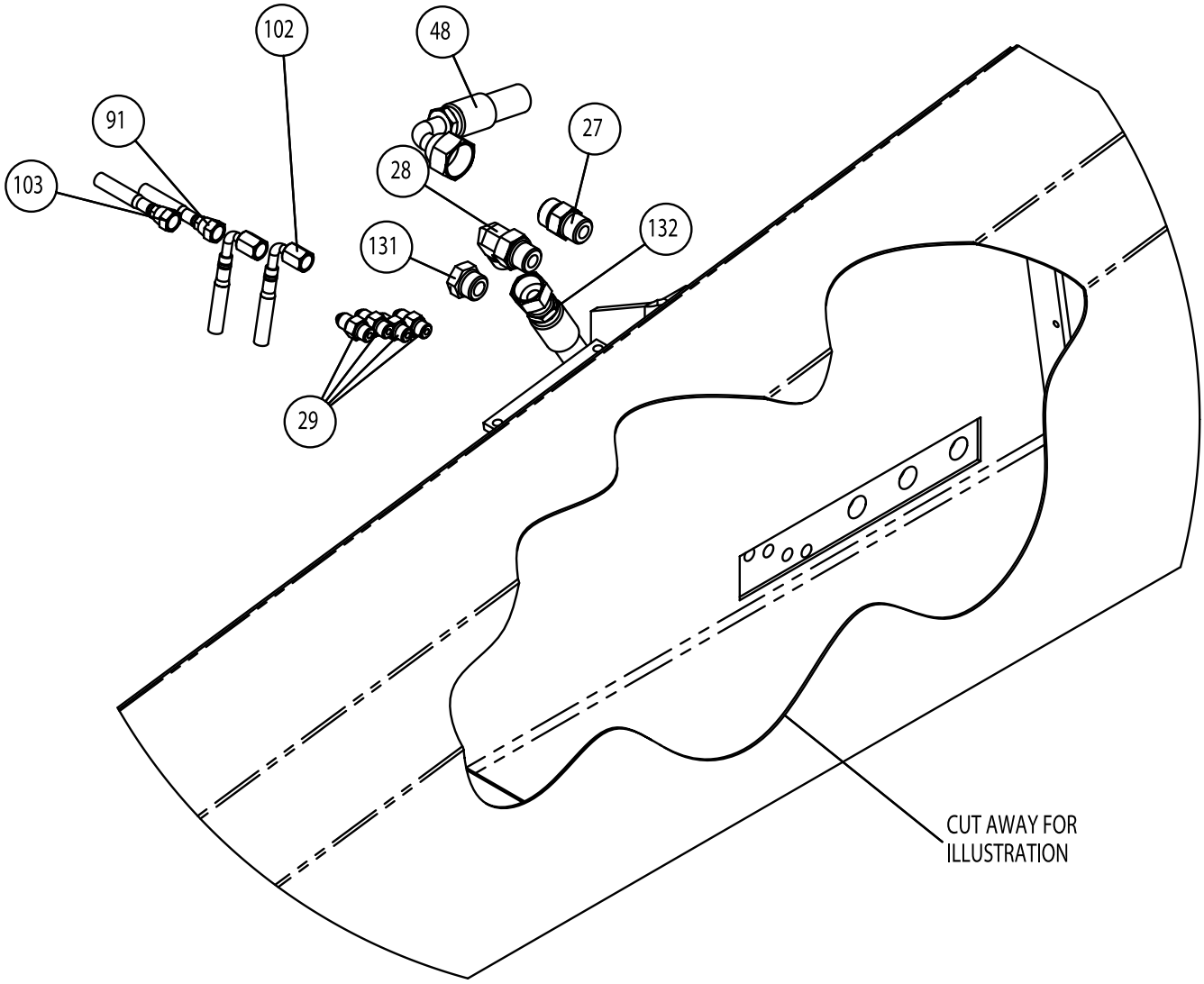
ITEM NO.	QTY.	PART NO.	DESCRIPTION
7	1	DRI-U-20030	JOY STICK CONTROLLER
88	1	DRI-U-10537	PLATE, UPPER INSTRUMENT
89	1	DRI-U-10536	PLATE, LOWER INSTRUMENT
90	6	202702-6-4S	FITTING
91	2	DRI-U-10744	HOSE ASSEMBLY
93	2	DRI-U-10743	HOSE ASSEMBLY
94	2	DRI-U-10742	HOSE ASSEMBLY
95	2	DRI-U-10741	HOSE ASSEMBLY
96	2	DRI-U-10739	HOSE ASSEMBLY
97	2	DRI-U-10740	HOSE ASSEMBLY
108	2	DRI-U-10749	HOSE ASSEMBLY
109	2	2096-45	FITTING
110	3	FF2032T0404S	FITTING
111	1	2240-0808S	FITTING, BULKHEAD
112	2	DRI-U-10750	HOSE ASSEMBLY
113	1	2018-0808S	FITTING
114	1	FF2114T0808S	FITTING
115	2	2244-0808S	FITTING
117	2	DRI-U-10751	HOSE ASSEMBLY

L. 4X GRUNDODRILL SUB-ASSEMBLY (I)



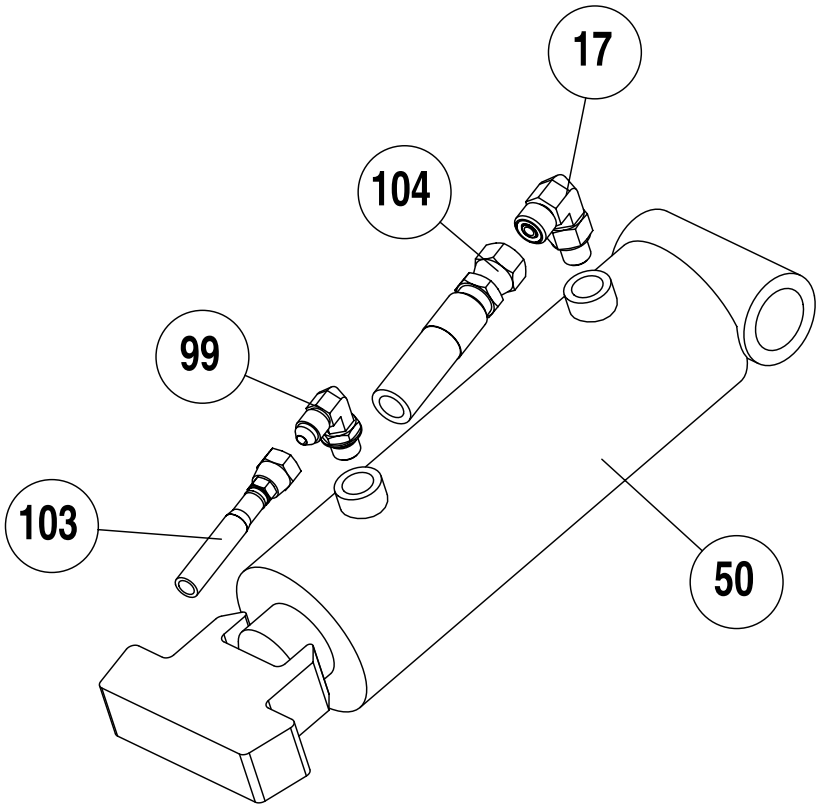
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	DRI-U-10389_	CYLINDER, BOOM TILT
2	1	DRI-U-10390_	CYLINDER, REAR STABILIZER
9	2	DRI-U-10703	HOSE ASSEMBLY
10	2	DRI-U-10704	HOSE ASSEMBLY
11	2	DRI-U-10705	HOSE ASSEMBLY
12	2	DRI-U-10706	HOSE ASSEMBLY
14	1	2041-4-4S	FITTING, BULKHEAD
15	2	DRI-U-10707	HOSE ASSEMBLY
16	2	DRI-U-10708	HOSE ASSEMBLY
17	10	FF1868T0404S	FITTING
18	2	DRI-U-10710	HOSE ASSEMBLY
19	2	DRI-U-10709	HOSE ASSEMBLY
20	2	FF1852T0406S	FITTING
29	9	202702-4-4s	FITTING
30	2	DRI-U-10713	HOSE ASSEMBLY
31	2	203102-4-4S	FITTING
32	2	4-4C4OMXS	FITTING
33	2	DRI-U-10714	HOSE ASSEMBLY
34	1	DRI-U-10715	HOSE ASSEMBLY
36	2	DRI-U-10817	HYDRAULIC LINE ASSEMBLY
37	8	FF1852T0608S	FITTING
38	2	DRI-U-10802	HYDRAULIC LINE ASSEMBLY
39	2	DRI-U-10803	HYDRAULIC LINE ASSEMBLY
40	2	DRI-U-10818	HYDRAULIC LINE ASSEMBLY
44	1	DRI-U-10804	HYDRAULIC LINE ASSEMBLY
45	1	DRI-U-10805	HYDRAULIC LINE ASSEMBLY
46	3	FF1852T0812S	FITTING
47	2	DRI-U-10717	HOSE ASSEMBLY
48	2	DRI-U-10718	HOSE ASSEMBLY
98	1	DRI-U-21600	VALVE, CUSHION
99	2	2062-4-4S	FITTING
100	1	2071-4-4S	FITTING
101	2	DRI-U-10745	HOSE ASSEMBLY
102	2	DRI-U-10746	HOSE ASSEMBLY
104	2	DRI-U-10748	HOSE ASSEMBLY

M. 4X GRUNDODRILL SUB-ASSEMBLY (J)



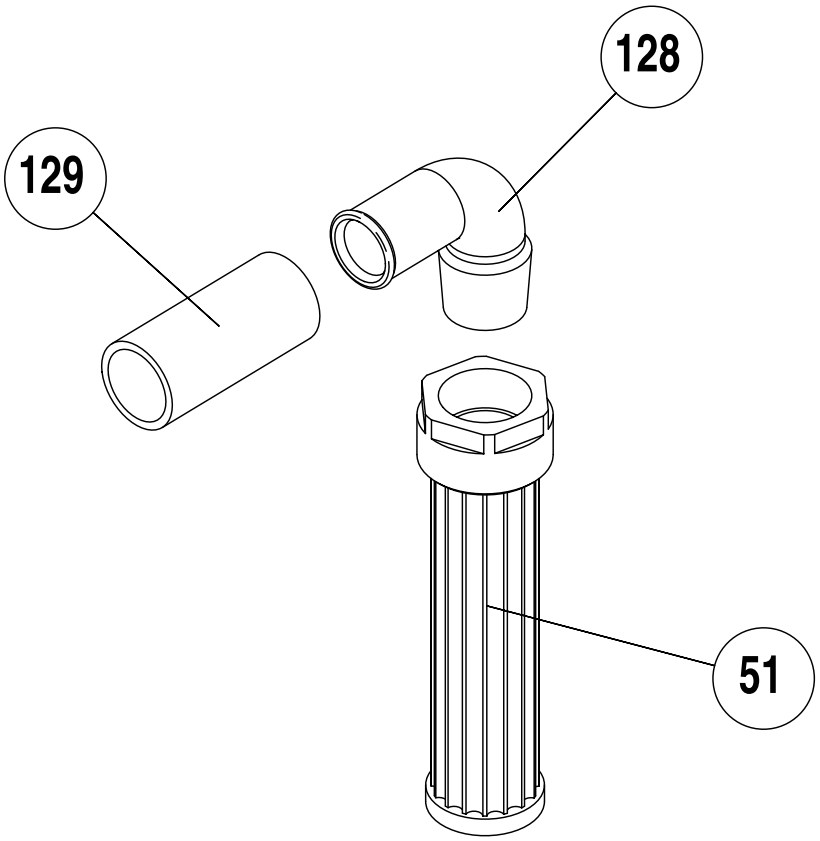
ITEM NO.	QTY.	PART NO.	DESCRIPTION
27	3	FF1852T0808S	FITTING
28	4	FF1868T0808S	FITTING
29	9	202702-4-4s	FITTING
48	2	DRI-U-10718	HOSE ASSEMBLY
91	2	DRI-U-10744	HOSE ASSEMBLY
102	2	DRI-U-10746	HOSE ASSEMBLY
103	2	DRI-U-10747	HOSE ASSEMBLY
131	1	8_P5ON-S	FITTING
132	2	DRI-U-10753	HOSE ASSEMBLY

N. 4X GRUNDODRILL SUB-ASSEMBLY (K)



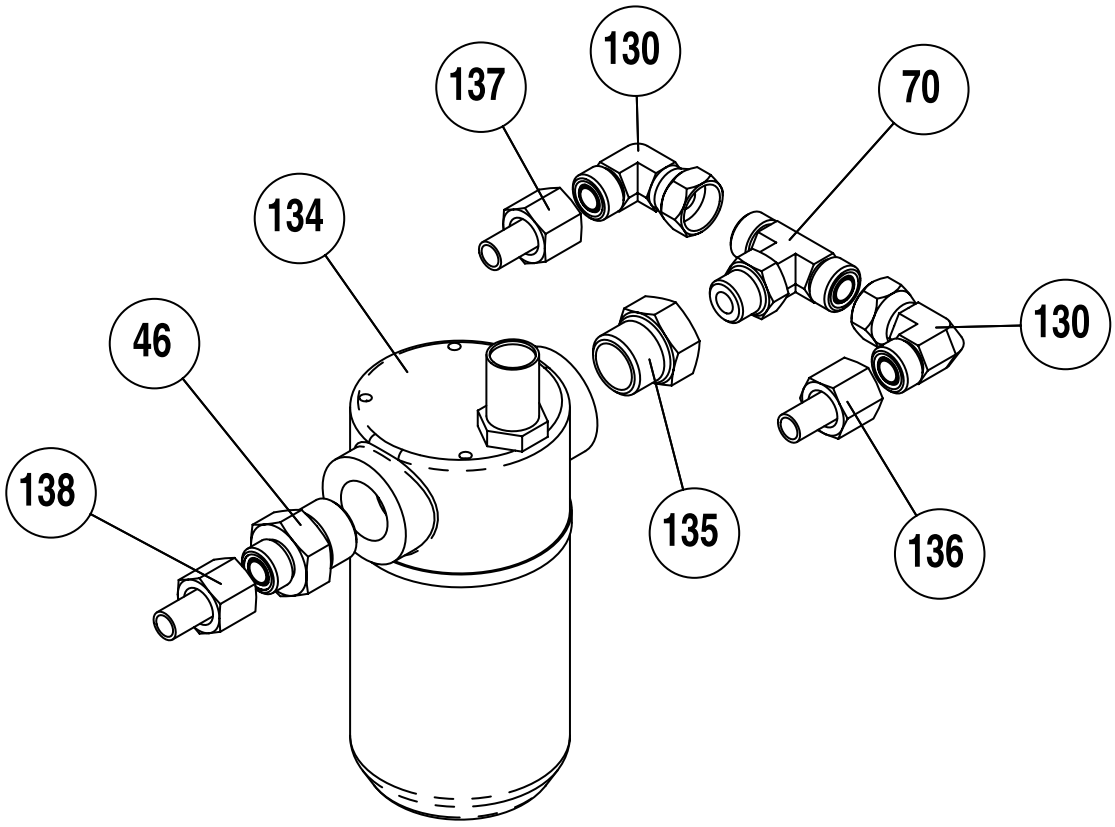
ITEM NO.	QTY.	PART NO.	DESCRIPTION
17	10	FF1868T0404S	FITTING
50	1	DRI-U-10262	CYLINDER STOP ASSEMBLY
99	2	2062-4-4S	FITTING
103	2	DRI-U-10747	HOSE ASSEMBLY
104	2	DRI-U-10748	HOSE ASSEMBLY

O. 4X GRUNDODRILL SUB-ASSEMBLY (L)



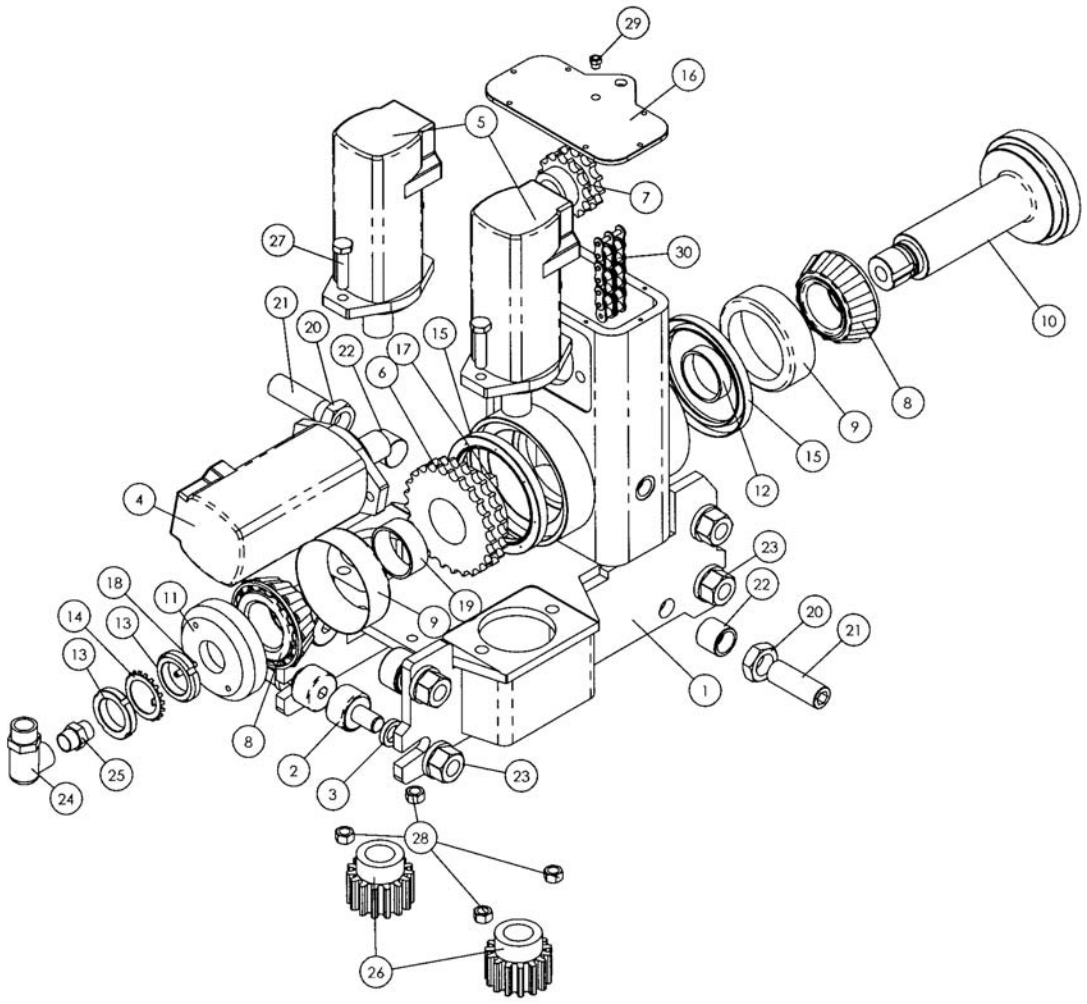
ITEM NO.	QTY.	PART NO.	DESCRIPTION
51	1	TF-1015-0-3	SCREEN ASSEMBLY
128	1	4501-16x16	FITTING
129	2	HOSE_16	HOSE

P. 4X GRUNDODRILL SUB-ASSEMBLY (M)



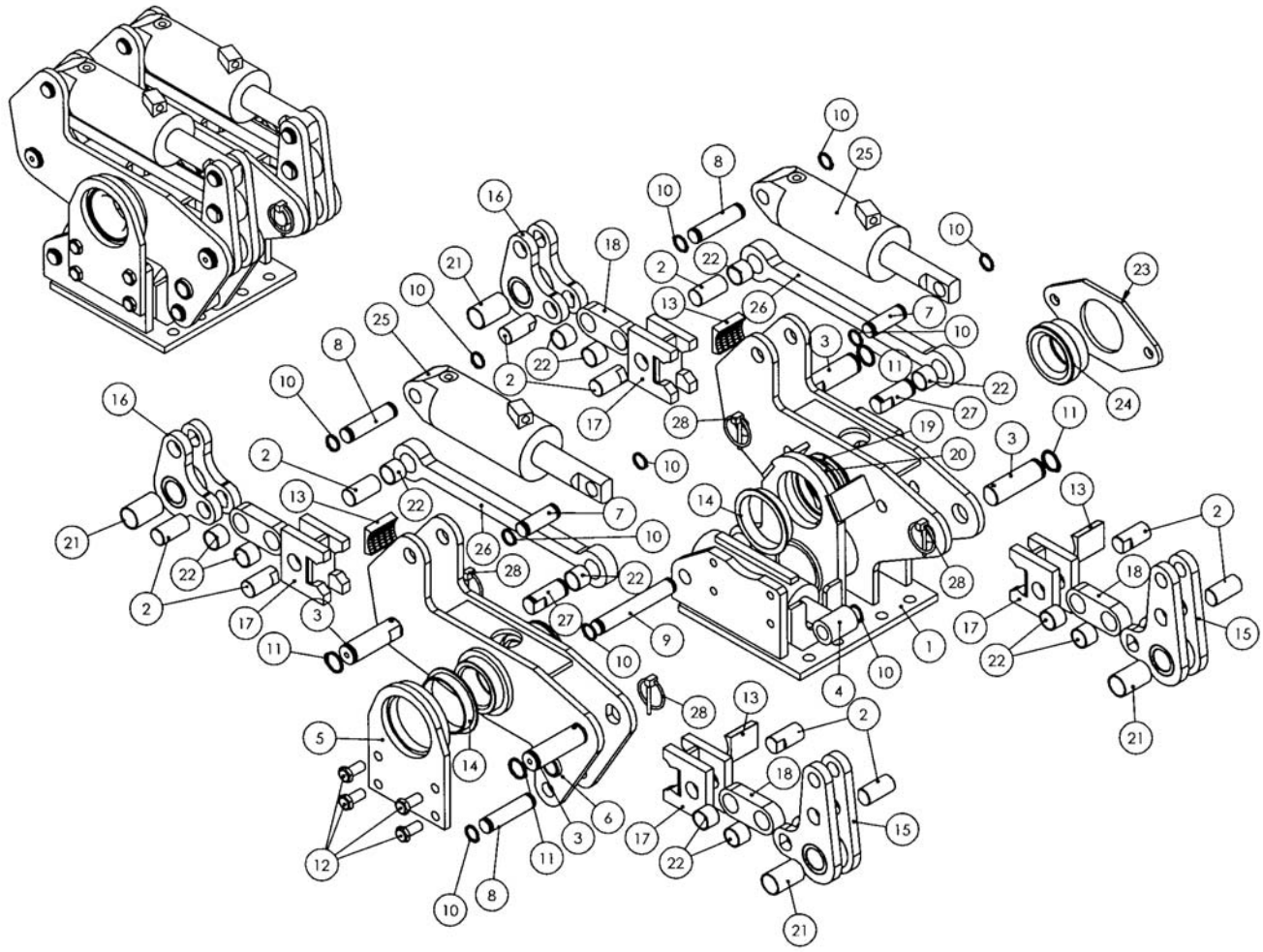
ITEM NO.	QTY.	PART NO.	DESCRIPTION
46	3	FF1852T0812S	FITTING
70	3	FF1861T0808S	FITTING
130	4	FF2098T0808S	FITTING
134	1	HH7414A12M8RBL	HYDRAULIC FILTER ASSEMBLY
135	1	12-8-F50G5-S	FITTING
136	2	DRI-U-10813	HYDRAULIC LINE ASSEMBLY
137	2	DRI-U-10814	HYDRAULIC LINE ASSEMBLY
138	2	DRI-U-10815	HYDRAULIC LINE ASSEMBLY

Q. 4X GRUNDODRILL DRILL HEAD ASSEMBLY



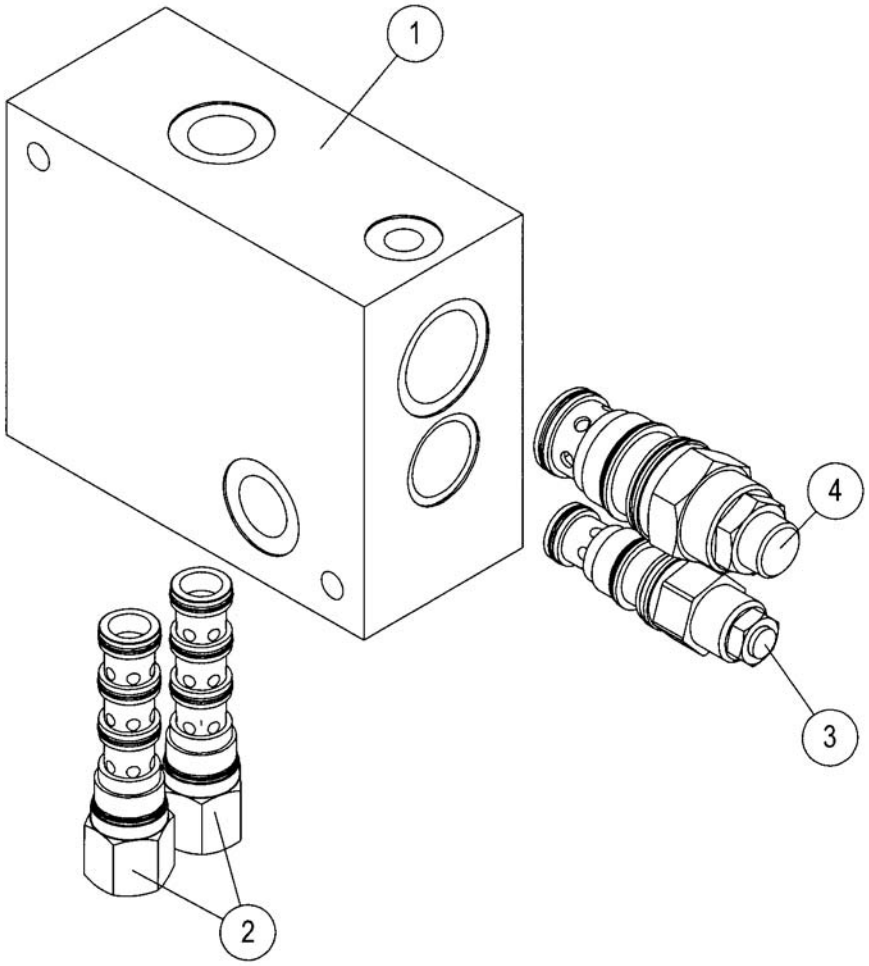
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	DRI-U-10249	WELDMENT, DRILL HEAD
2	8	CF-175-SB	CAM FOLLOWER - McGILL # CF-175-SB
3	8	98099A036	BUSHING - McMASTER CARR # 98099A036
4	1	DRI-U-20050	MOTOR, THRUST - 4X
5	2	DRI-U-20060	MOTOR, THRUST - 4X
6	1	DRI-U-10578	SPROCKET, D50 X 24 TOOTH
7	1	DRI-U-10579	SPROCKET, D50 X 13 TOOTH
8	2	539	BEARING
9	2	532	BEARING CUP
10	1	DRI-U-10398	SHAFT, SPINDLE
11	1	DRI-U-10399	PLATE, SEAL
12	1	DRI-U-10401	SPACER
13	2	N-08	NUT - 6030
14	1	W-08	WASHER
15	2	CR43691	SEAL
16	1	DRI-U-10405	COVER
17	1	DRI-U-10404	KEY 1/2 X 1/2
18	1	rollpin25X112	ROLL PIN, 1/4" DIA. X 1.125"
19	1	DRI-U-10400	SPACER
20	2	nutjam100	JAM NUT, 1-8
21	2	DRI-U-10414	ADJUSTER SCREW
22	2	DRI-U-10142	BLOCK, BEARING
23	8	91030A450	NUT, 3/4-16 McMASTER CARR# 91030A450
24	1	SWIVEL	SWIVEL
25	1	FITTING	FITTING
26	2	DRI-U-10577	PINION GEAR
27	4	hhcsM12X1_75X50	HHCS, M12 X 1.75 X 50mm
28	4	nut12mm	NUT, 12 mm
29	1	BREATHER	BREATHER
30	1	DRI-U-10293	CHAIN

R. 4X GRUNDODRILL WRENCH ASSEMBLY



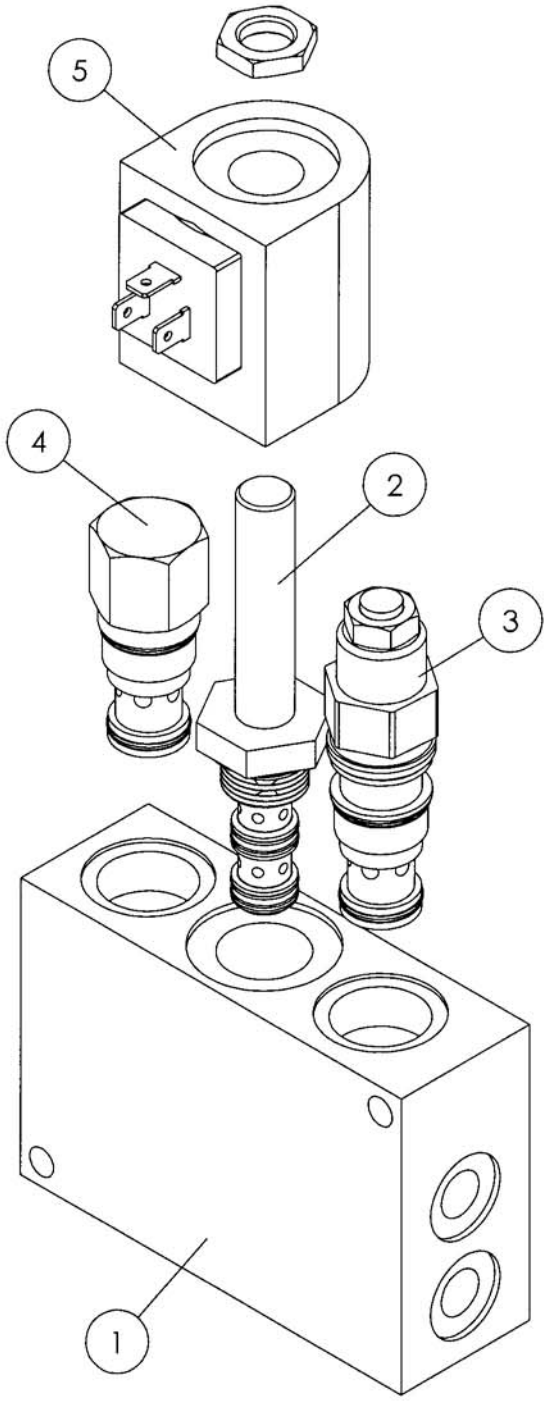
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	DRI-U-10244	WRENCH FRAME, FIXED
2	10	DRI-U-10373	PIN, TRANSFER
3	4	DRI-U-10516	PIN, END LINK
4	1	DRI-U-10386	CYLINDER, ROTATION
5	1	DRI-U-10246	PIVOT PLATE
6	1	DRI-U-10245	WRENCH FRAME, PIVOT
7	2	DRI-U-10169	PIN, CYLINDER CLEVIS
8	3	DRI-U-10170	PIN
9	1	DRI-U-10167	PIN
10	12	SHR-75	RETANING RING, .750 DIA. - ROTOR CLIP# SHR-75 STDI
11	4	SHR-98	RETANING RING, 1.000 DIA. EXTERNAL
12	4	hhcsm12x1_75x25	HHCS, M12 X 1.75 X 25mm
13	4	DRI-U-10174	JAW (48mm)
14	2	DRI-U-10378	BEARING (IGUS# GFI-4447-32 MODIFIED)
15	2	DRI-U-10254	LINKAGE ARM
16	2	DRI-U-10277	PIVOT ARM
17	4	DRI-U-10282	JAW CARRIER (48mm)
18	4	DRI-U-10422	LINK, CONNECTOR
19	1	SH-275	RETANING RING, ROTOR CLIP # SH-275
20	1	DRI-U-10443	THRUST WASHER
21	4	PF1618-28	BEARING - POLYGON# PF1618-28
22	12	60695K67	BEARING
23	1	DRI-U-10483	PLATE, BUSHING KEEPER
24	1	DRI-U-10531	GUIDE (48mm)
25	2	DRI-U-10426	CYLINDER, CLAMP
26	2	DRI-U-10513	TRANSFER BAR
27	2	DRI-U-10515	PIN, TRANSFER BAR
28	4	90170A650	LINCH PIN - McMASTER CARR # 90170A650

S. 4X GRUNDODRILL LOOP FLUSHING MANIFOLD



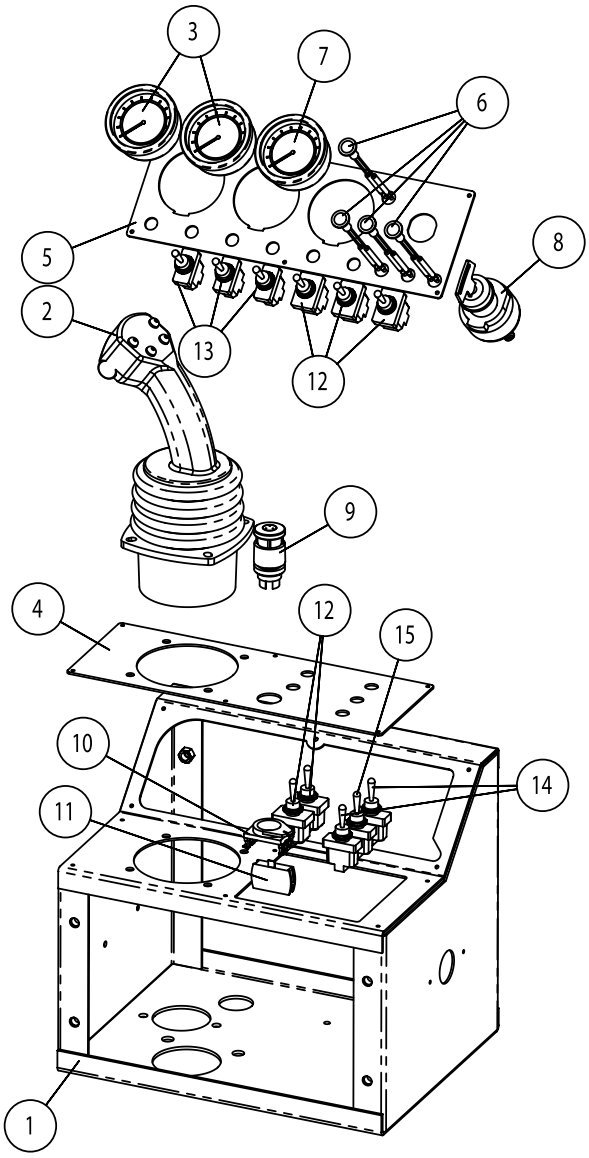
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	BLOCK_LOOP_FLUSHING	MANIFOLD, LOOP FLUSHING
2	2	DSCH-XGN	CHECK VALVE
3	1	RSDC-LDN	PRESSURE RELIEF VALVE
4	1	RSFC-LDN	PRESSURE RELIEF VALVE

T. 4X GRUNDODRILL CUSHION VALVE BLOCK



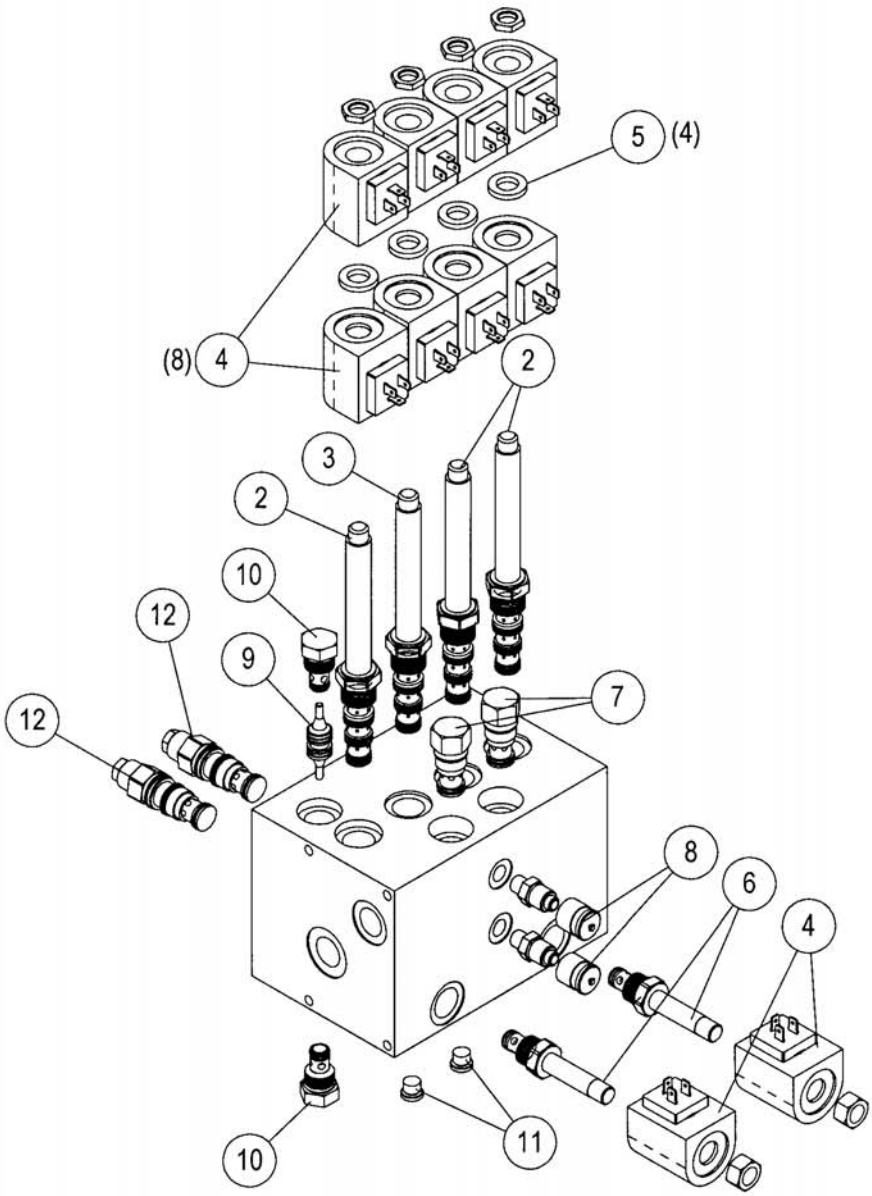
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	02-0823	BLOCK, CUSHION VALVE
2	1	PF-S3A-00	VALVE
3	1	RPEC-LAN	PRESSURE RELIEF VALVE
4	1	CXBA-XAN	CHECK VALVE
5	1	HC12	COIL

U. 4X GRUNDODRILL CONTROL PANEL



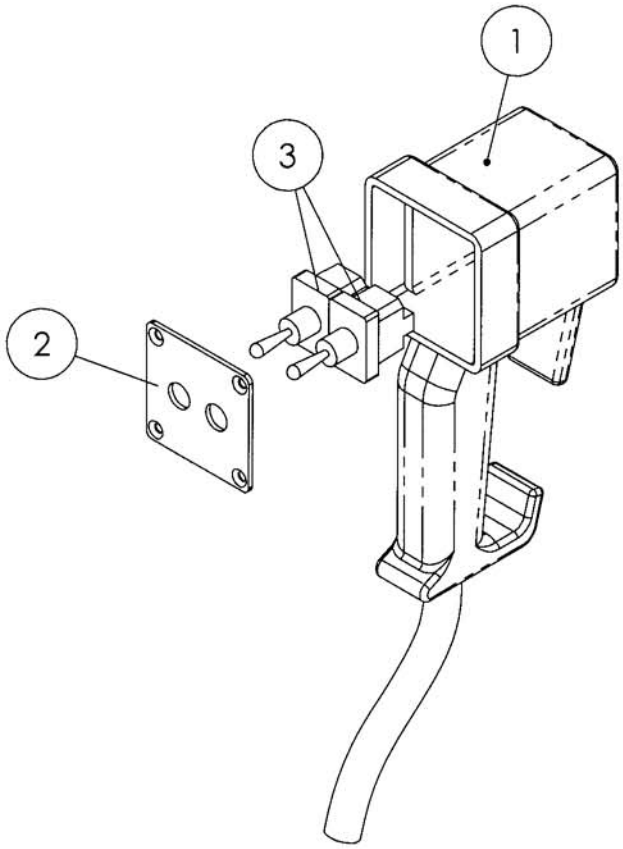
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	DRI-U-10231	ENCLOSURE, CONSOLE
2	1	DRI-U-20030	JOY STICK CONTROLLER
3	2	DRI-U-22050	GAUGE
4	1	DRI-U-10536	PLATE, LOWER INSTRUMENT
5	1	DRI-U-10537	PLATE, UPPER INSTRUMENT
6	4	DRI-U-10285	INDICATOR LIGHT
7	1	DRI-U-22060	GAUGE (BENTONITE)
8	1	1E013-63590	KEY SWITCH
9	1	C20DQ01	EMERGENCY STOP OPERATOR
10	1	233E	CLIP
11	1	23E01	CONNECTOR BLOCK
12	5	2NT1-7	SWITCH
13	3	1NT1-2	SWITCH
14	2	1NT1-1	SWITCH
15	1	1NT1-7	SWITCH

V. 4X GRUNDODRILL MAIN VALVE MANIFOLD



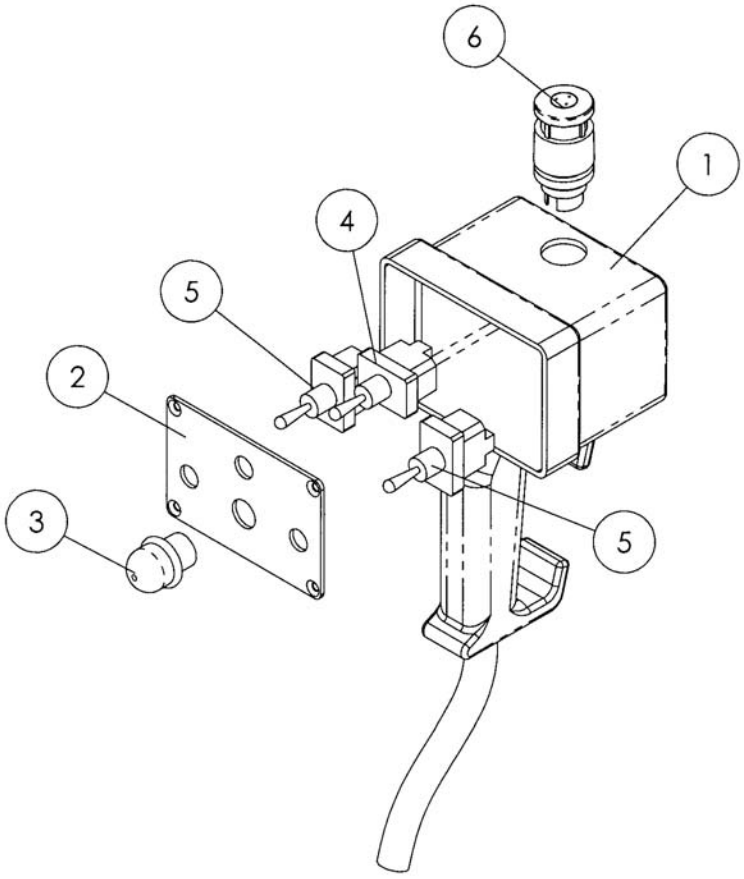
ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	MANIFOLD_MAIN_VALVE	MANIFOLD, MAIN VALVE
2	3	DG-S4M-00	VALVE
3	1	DG-S4P-00	VALVE
4	10	HC12	COIL
5	4	SPACER	SPACER
6	2	DE-S2D-00	VALVE
7	2	CXDA-XCN	CHECK VALVE
8	2	EMA3-7-16-20UNF-2A	TEST PORT
9	1	70133805	PILOT PISTON
10	2	MA-CVA-00-0005-X	CHECK VALVE
11	2	PLUG_03	PLUG
12	2	RVCA-LAN	PRESSURE RELIEF VALVE
13	1	DG-S4M-00-HC12	VALVE ASSEMBLY - DG-S4M-00 (1EA.) & HC12 (2EA.)
14	1	DG-S4P-00-HC12	VALVE ASSEMBLY - DG-S4P-00 (1EA.) & HC12 (2EA.)

W. 4X GRUNDODRILL MCMASTER CARR ENCLOSURE #9215K11



ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	9215K11	ENCLOSURE - McMASTER CARR # 9215K11
2	1	DRI-U-10581	PLATE, STAKE DOWN CONTROL
3	2	2NT1-7	SWITCH

X. 4X GRUNDODRILL MCMASTER CARR ENCLOSURE #9215K12



ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	9215K12	ENCLOSURE - McMASTER CARR #9215K12
2	1	DRI-U-10580	CONTROL PLATE - TRACK DRIVE
3	1	CH90030	SWITCH, MASTER - TERMINAL SUPPLY # CH90030
4	1	1NT1-2	SWITCH
5	2	2NT1-1	SWITCH
6	1	6741K11	EMERGENCY STOP OPERATOR - McMASTER CARR #6741K11

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